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Remedial Action and Final Radiological Status, 1964 B-58 Accident Site, Grissom Air Reserve Base, Bunker Hill, Indiana

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December 2000

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13. ABSTRACT *(Maximum 200 words)*

On 8 December 1964, during a routine Operational Readiness Inspection, a B-58 strategic bomber skidded off the runway at Bunker Hill AFB IN (later named Grissom AFB). The consequence of the accident was a fire and destruction of five nuclear weapons on the aircraft. The high explosives in the weapon did not detonate, but melted and burned, leaving residual radioactive contamination in soils adjacent to the runway. The contaminated area was excavated and buried along with the aircraft wreckage at a different location on base. The burial site is now part of the Base Realignment and Closure Commission. In 1999, AFIERA performed a radiological characterization of the site [IERA-SD-TR-2000-0002 (Available from NTIS)]. The results of the survey confirm that a small area of the investigation region contained depleted uranium (DU). AFIERA developed a remedial action plan for the site [IERA-SD-TR-2000-0011 (Available from NTIS)]. The goal was to select areas for remediation where surface soils DU contamination levels exceeded 6.4 pCi/g of DU, with a final status goal not to exceed 8 pCi/g. This report describes remedial actions completed and final site status. An area of 300 square meters was remediated, with excavated volume estimated at 105 cubic meters. The residual DU on the site is estimated at 1.3 pCi/g, based on final status soil samples. The remedial action met all goals. Although the installation has no present interest in utilization of the site for other purposes, the site meets unrestricted public use criteria recommended by the Environmental Protection Agency. No further remedial actions are recommended for the site.

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List of Abbreviations and Acronyms

^{241}Am	americium-241	$^{239/240}Pu$	plutonium-239 & -240
^{241}Pu	plutonium-241	^{90}Sr	strontium-90
^{234}Th	thorium-234	^{234}U	uranium-234
^{235}U	uranium-235	^{238}U	uranium-238
cm	centimeter	CI	confidence interval
CV	coefficient of variation	dpm	disintigration per minute
DU	depleted uranium	γ	gamma
g	gram	ft	feet
GPS	geopositional system	HQ	Headquarters
in	inch	kcpm	kilo counts per minute
lbs	pounds	m	meter
$\mu g\ G^{-1}$	microgram per gram	$\mu Ci\ g$	microcuries per gram
$mg\ L^{-1}$	milligram per liter	$mrem\ y^{-1}$	millirem per year
N	north	NA	not applicable
$pCi\ g^{-1}$	picocuries per gram	QA	quality assurance
QC	quality control	RPD	relative percent difference
s	second	σ	sigma
Tl	thallium	V	volts
W	west	y	year

AFBCA	Air Force Base Conversion Agency
AFIERA	Air Force Institute for Environment, Safety, Occupational Health Risk Analysis
ALARA	as low as is reasonably achievable
ARW	Air Refueling Wing
BRAC	Base Realignment and Closure
CFR	Code of Federal Regulations
EPA	Environmental Protection Agency
IDH	Indiana Department of Health
IDEM	Indiana Department of Environmental Protection
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimal detectable concentration
NRC	Nuclear Regulatory Commission
ORI	Operational Readiness Inspection
OSC	Operations Support Command
RASS	remedial action support survey
TCLP	toxicity characteristic leaching procedure
WGP	weapons grade plutonium

Definitions

ALARA: the practice of reducing radiation dose levels below specified limits using a cost-benefit analysis.

Curie: a unit of radioactivity equivalent to 3.7×10^{10} nuclear transformations (also referred to as disintegration) per second. One pCi is equivalent to 10^{-12} Ci or 0.037 nuclear transformations per second.

dose equivalent: for the purposes of this report, the terms dose equivalent, effective dose equivalent, and dose will be used interchangeably. The effective dose equivalent is the sum of the weighted dose equivalents for irradiated tissues or organs from ionizing radiation sources. It takes into account the different mortality risks from cancer and the risk of severe hereditary effects. A common unit for dose equivalent in the US is the mrem. For comparison to remediation criteria discussed in the report, the average American annually receives about 350 mrem from naturally occurring sources of radiation in the environment.

enriched uranium: uranium with a higher ^{235}U mass fraction than that of natural uranium.

half-life: the period of time required for any given isotope to decrease to one-half of its original quantity.

isotopes: variation in the number of neutrons in the nuclei of atoms of the same element. For example, three common isotopes of uranium: ^{234}U, ^{235}U, and ^{238}U only differ in the number of neutrons in the nucleus. Isotopes of the same element generally behave the same chemically, but can have significantly different nuclear properties (i.e., nuclear interactions and radioactivity).

minimal detectable concentration: the smallest concentration of radioactivity that can be measured under specified conditions.

pH: the negative logarithm of the effective hydrogen concentration in gram equivalents.

radioactivity: a property exhibited by some nuclei undergoing spontaneous nuclear transformation that has accompanying radioactive particle and/or electro-magnetic emissions.

remedial action support survey: a survey accomplished after a remedial action to verify the effectiveness of an action.

secular equilibrium: a condition where a decay product (commonly called "daughter") isotope has a very short radiological half-life compared to the radiological half-life of the "parent" isotope. In these cases, the radioactivity of the parent and daughter will be the same.

weapons grade plutonium: artificially produced type of plutonium that by mass is predominately the fissile ^{239}Pu. Fissile isotopes of elements are capable of forming critical masses of material necessary for a nuclear chain reaction.

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1. Introduction

a. Purpose. This report describes the remedial action work and final status survey accomplished at the B-58 accident site on Grissom Air Reserve Base (ARB). Remediation actions described in this report were limited to a 300 m^2 site in a grassy area alongside NE-SE Runway 23 and were accomplished by Cabrera Remediation Services Inc under contract to the US Army Operations Support Command (OSC). The 300 m^2 site was the only contaminated area within a considerably larger survey area based on the characterization survey (Rademacher and Hoak 2000). Radiological surveys and supervision of the remedial actions were accomplished by the Radiation Surveillance Division of the AF Institute for Environment, Safety and Occupational Health Risk Analysis (AFIERA). The Indiana Departments of Health and Environmental Management (IDH and IDEM) reviewed survey and workplan documents for the site, and participated in field activities as an independent observer. The site was contaminated by a nuclear weapons accident that occurred 8 December 1964 when a B-58 strategic bomber skidded off the runway and caught fire. In 1964, the B-58 wreckage and some contaminated soils from the accident site were buried at another location that is now part of the Base Realignment and Closure (BRAC) Commission property. The aircraft burial site investigation is being accomplished by the Air Force Base Conversion Agency (AFBCA) and is described in other documents. The remedial action goals described in the remedial action plan for the accident site (Rademacher 2000), including soil removal, in-situ γ-measurements, and soil sampling were met. Although the 434th Air Refueling Wing (ARW) plans to retain the property, the site meets an unrestricted public release dose rate criterion of 15 mrem y^{-1} recommended by the Environmental Protection Agency (EPA).

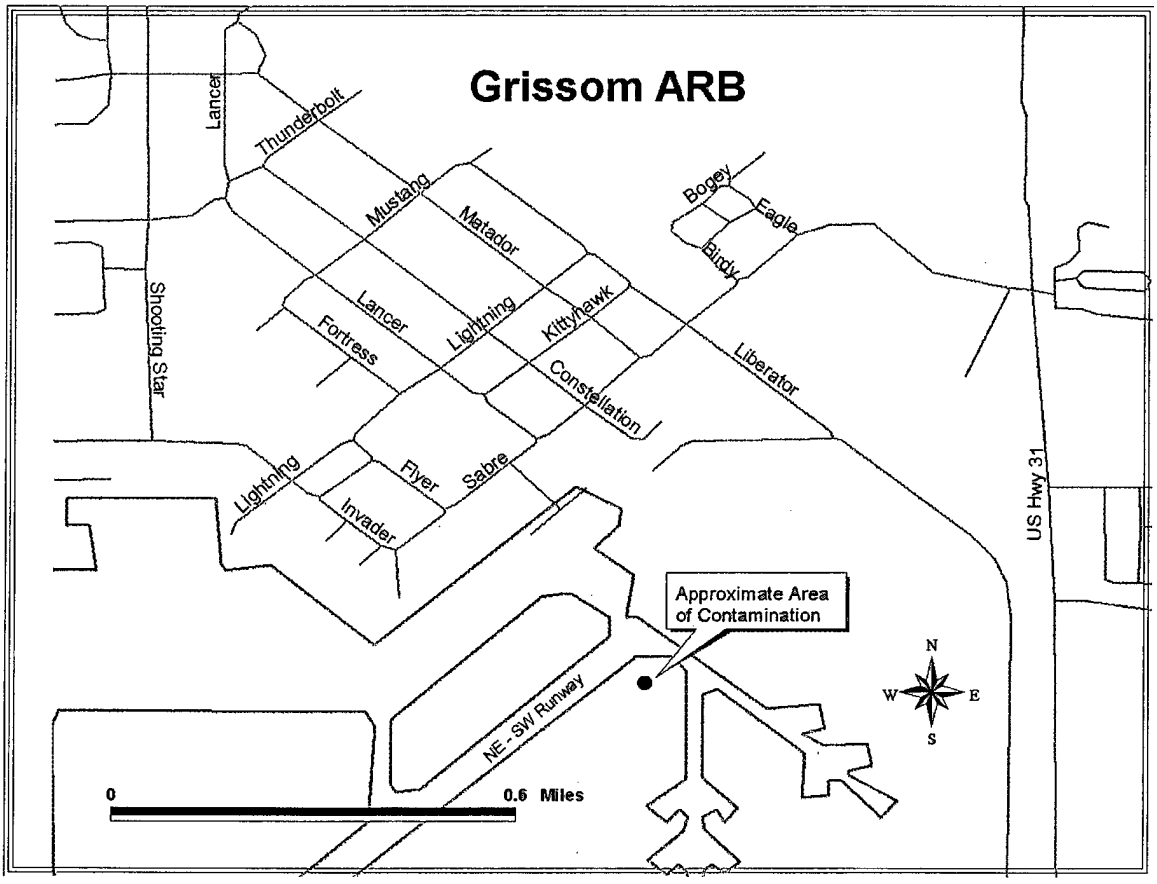
b. Site Description.

Grissom AFB was realigned under the BRAC Commission and was renamed Grissom ARB. Grissom ARB maintains military planes and the runway with the 434th ARW. The Wing is equipped with 22 KC-135 aircraft and 1,300 personnel. The accident site is alongside NE-SW Runway 23 (Figures 1 and 2). The area is bounded by a concrete runway and taxiways, and contains aircraft navigational aids and a windsock in its center. The vegetation consists of native grasses that are mowed on a regular basis to a height of less than 15 cm (0.5 ft). The terrain is relatively flat, but is marked by irregularly spaced depressions less than 30 cm (1 ft) deep. Approximately 50 m

(160 ft) southwest from the windsock, a drainage ditch is terminated in a culvert. Due to its close proximity to active flight operations, access to the site is tightly controlled.

The primary contaminated area identified and described in the characterization survey report (Rademacher and Hoak 2000) was not in the immediate location of the aircraft crash site. The primary contaminated area identified and remediated was about 50 m (160 ft) from the crash site. This area corresponds to a shallow trench that was used to assist in extinguishing a persistent fire that engulfed one of the weapons. The only radioactive contaminant identified was depleted uranium (DU). During remediation, many small and one large DU slag were uncovered in a highly localized area that previously generated the highest in-situ γ-measurements and soil sampling results. The large slag appeared to be fused with small pebbles and sand, consistent with the historical record of the accident. This location is referred to as the "hot-spot" in other portions of the report.

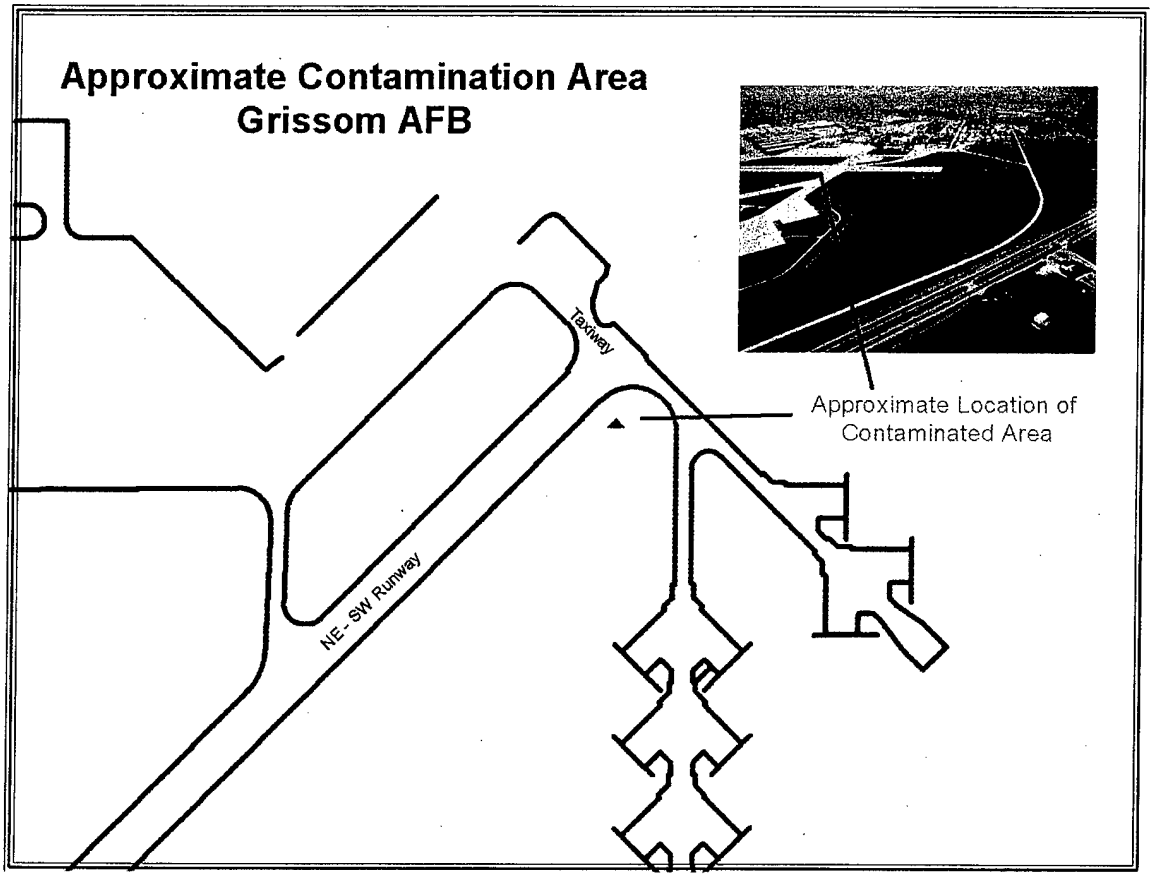
Figure 1: Site Location and Surrounding Area.



c. Summary of Completed Actions. The actions were completed in five phases. The pre-remediation site survey was accomplished 1 August 2000. The survey consisted of 330 in-situ

γ-radiation measurements and soil samples for waste profiling. Soil removal operations were accomplished from 12 – 14 September 2000. Post removal, the area was scanned to locate any potential areas of residual contamination. A detailed remedial action support survey (RASS) was accomplished with fixed in-situ γ-measurements of the remediated area on 14 September 2000. Soil sampling was accomplished in a region equally comprised of the remediated area and immediate surrounding area. Soil sampling results and the RASS support the final site status. Clean soil was backfilled in the remediation area on 15 September 2000 and seeded for grass.

Figure 2: Site Location.



d. Summary of Final Site Status. In support of final site status determination, 25 soil samples were collected on a triangular grid pattern that encompassed the remediation area and an equal surrounding area for a total of 600 m^2 (6,500 ft^2). Based on laboratory analysis, the mean residual DU on the site is estimated at 1.3 pCi g^{-1}. Based on this activity concentration level, the calculated dose equivalent level for hypothetical future site residents had a maximum of 0.2 mrem y^{-1}. This level is well below the 15 mrem y^{-1} criterion recommended by the EPA.

2. Historical Site Assessment

a. Historical Record of Accident.

On 8 December 1964, during a routine Operational Readiness Inspection (ORI), a B-58 strategic bomber skidded off the runway at Bunker Hill AFB IN (later renamed Grissom AFB). The landing gear subsequently collapsed, rupturing a fuel tank. The ensuing fire burnt portions of the five nuclear weapons on board the aircraft. The high explosives in the weapons did not detonate, although some portions melted and burned (Sandia 1997). One burning weapon was removed from the accident area and extinguished by placing it in a shallow trench and covering it with sand. The trench was approximately 50 m (160 ft) from the aircraft wreckage in the grassy area between the runway and alert area taxiway. The historical record indicates radioactive contamination was confined to a 2 m x 6 m x 0.1 m (7 ft x 20 ft x 0.3 ft) volume (HQ Air Force Safety Center 1996). The precise location of the trench is unknown from the historical record. The contaminated soil around the aircraft wreckage was excavated and buried along with the aircraft debris at a different location on the base that now is the responsibility of the AFBCA (outside 434 ARW property). Extensive sampling of the area soon after the accident supported the claim that the area was contamination free. However, written documentation of post accident sampling has not been located. Additionally, instrumentation available at the time of the accident (primarily alpha scintillation and Geiger-Mueller detectors) coupled with the wet conditions questions sufficiency of detection of residual contamination with respect to present standards.

The recovered weapons and weapons debris were sent to Atomic Energy Commission facilities in Clarksville TN, Medina Base TX, Rocky Flats CO, Miamisburg OH, and Oakridge TN (Sandia 1997). Subsequent analysis of the damaged weapons and debris indicated that plutonium was not released to the environment because all of the plutonium-bearing components were intact (Rademacher 1999a).

In June of 1996, the HQ Air Force Safety Center, at the request of Grissom ARB, conducted a review of classified and unclassified documents in its possession and concluded that sufficient data did not exist to support unrestricted release of the site (HQ Air Force Safety Center 1996).

b. Scoping Surveys. In 1996, the IDH performed γ-radiation exposure rate measurements and collected soil samples from the accident site. The IDH identified a small area with γ-radiation exposure rates 8 to 10 times background rates. Soil samples collected from this area contained

concentrations that were several hundred times background for ^{238}U. ^{235}U and ^{234}U concentrations were also elevated in proportion to that of depleted uranium, with the highest total uranium activity concentration over 700 pCi g^{-1}. Plutonium concentrations were consistent with levels typical of the background (EPA 1996). AFIERA conducted a scoping survey in May 1999 and collected five soil samples that had the isotopic composition of depleted uranium, with the highest total uranium activity concentration being 95 pCi g^{-1}.

c. Characterization Survey. AFIERA performed a comprehensive site characterization in October 1999 that consisted of fixed and scanning in-situ γ-measurements, and extensive soil sampling (Rademacher and Hoak 2000). An 8,800 m^2 (95,000 ft^2) land area in square grids of 100 m^2 (1,100 ft^2) was evaluated to determine background radiation levels; identify areas of elevated in-situ γ-radiation levels; and quantify uranium, americium, and chemical concentrations in soils. The scanning survey identified only one area of elevated contamination as shown by the pink box on the site grid of Figure 3. The pink box roughly encompassed 300 m^2 (3,200 ft^2) and had an estimated mean excess total uranium (i.e., not attributed to natural background) surface activity concentration of 15 to 20 pCi g^{-1} (Rademacher and Hoak 2000). Figure 4 provides a more detailed map of the contaminated area with notation of the mean surface soils sampling results (^{234}Th) for each grid and fixed in-situ γ-measurements in the hot-spot area. ^{234}Th is typically used to quantify uranium because it is in the decay chain of ^{238}U and has an abundant γ-radiation emission. The pink rectangular box is similar in placement to the area of elevated concentration in Figure 3. For the 10 grids with mean surface ^{234}Th activity concentrations greater than 2 pCi g^{-1} (about two times natural background), the mean excess uranium activity concentration was about 7 pCi g^{-1}. Chemical analysis of targeted soil samples had beryllium concentrations typical for background. ^{241}Am activity concentrations were below the minimal detectable concentration (MDC) [ranged from 0.03 to 0.21 pCi g^{-1}] for the γ-spectroscopy system used. ^{241}Am is a daughter of ^{241}Pu and a co-contaminant of weapons grade plutonium (WGP). Based on other sites contaminated with WGP from the time period of this accident, the $^{239/240}Pu$ to ^{241}Am activity concentration ratio is about 5.4 (Rademacher 1999b), making sample $^{239/240}Pu$ activity concentrations less than 1.1 pCi g^{-1}.

d. Contaminants of Concern. Based on the results of the AFIERA characterization study, the only contaminant of concern is depleted uranium (natural uranium depleted in ^{235}U and ^{234}U isotopes). Table 1 contains the isotopic composition of natural and depleted uranium. Uranium, a naturally occurring radioactive element, is silver-white in its pure form. It is a heavy metal nearly

twice as dense as lead (19 g cm^{-3}). Uranium occurs in nature in a wide variety of solid, liquid, and gaseous compounds. It readily combines with other elements to form uranium oxides, silicates, carbonates and hydroxides. These compounds range from the highly mobile (e.g., carbonates) to the relatively immobile oxides. Hot-fired uranium in oxygen environments readily forms the oxides UO_2, U_3O_8, and U_2O_7.

Figure 3. Site with Contaminated Area Denoted by Pink Rectangular Box.

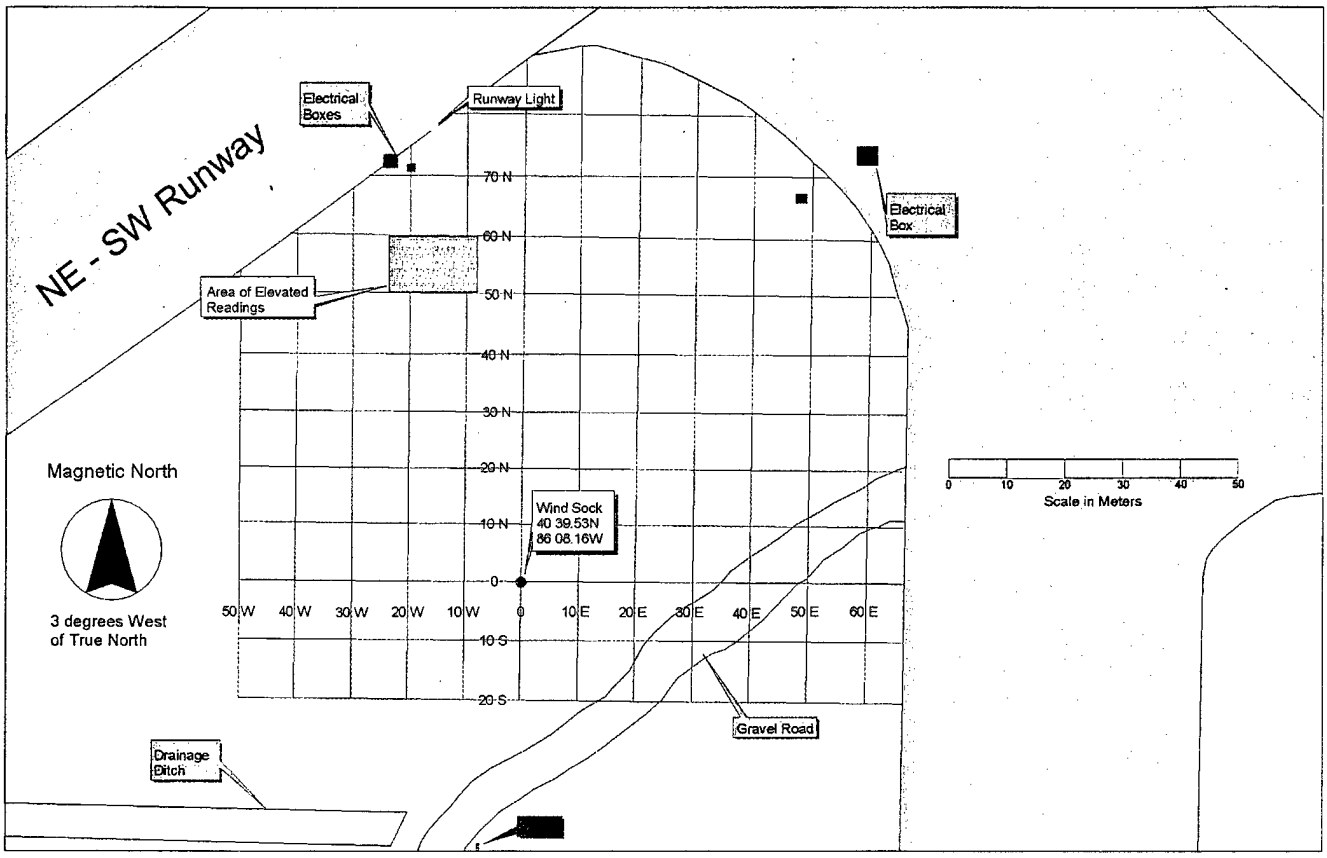
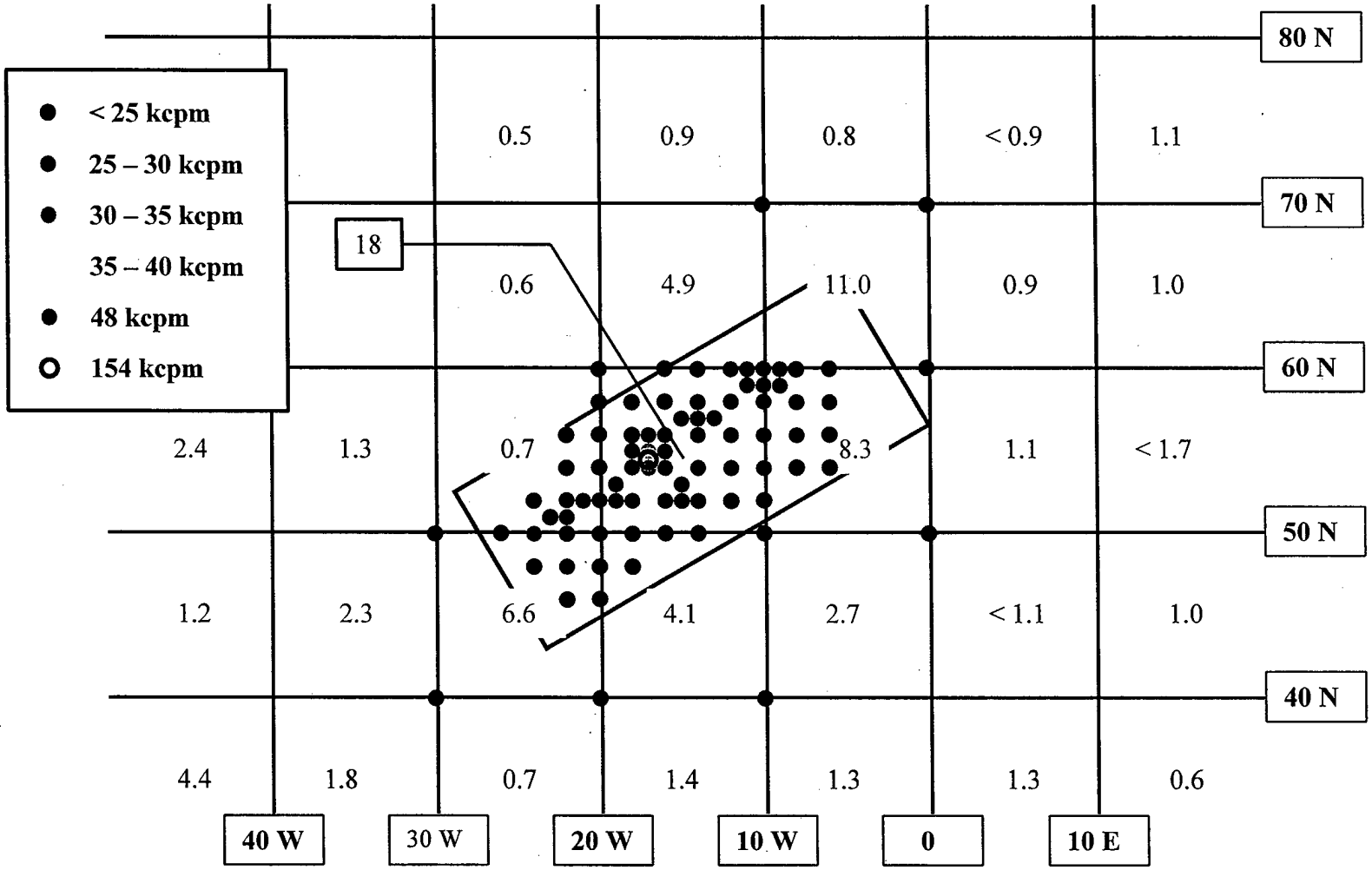


Table 1. Isotopic Ratios of Natural and Depleted Uranium (DU).

Material	Component by Weight Percentage				Specific Activity ($\mu Ci\ g^{-1}$)
	^{234}U	^{235}U	^{236}U	^{238}U	
Natural U	0.0057%	0.72%	0%	99.28%	0.7
Depleted Uranium	0.0001%	0.20%	0.0003%	99.8%	0.4

Figure 4. Fixed In-Situ Gamma Measurement Results for Hot-Spot Area and Accompanying Mean Grid Surface Soil Sampling Results for ^{234}Th (pCi g^{-1}) – Grid in Meters (Rademacher and Hoak 2000).



3. Remediation Goals

The characterization report contains dose estimates for hypothetical residents inhabiting the site in a contaminated condition (Rademacher and Hoak 2000). Hypothetical residents on the site are assumed to consume food grown on the land and water from an underground aquifer. Dose estimates were calculated with RESRAD Version 5.82 (Yu, *etal* 1993), a computer code developed at Argonne National Laboratory. The code accounts for radiation exposure from a multitude of routes including external γ-radiation, food and water consumption, and inhalation of resuspended soil particles. The code converts residual radioactive material activity concentrations in soils (expressed in pCi g^{-1}) into projected annual dose equivalent (expressed in mrem y^{-1}).

Table 2 contains a summary of the RESRAD calculations from the characterization report. The fourth data row contains an estimate of annual dose equivalent under the worst case assumption that all of the contaminant is concentrated in a 300 m^2 area. The value of 5.4 mrem y^{-1} is a small fraction of 300 mrem y^{-1}, the average background radiation dose equivalent Americans receive, and below remediation criteria provided by regulatory agencies for exposures to the general public.

Table 2. RESRAD Dose Estimates with Various Parameters and Assumptions (Rademacher and Hoak 2000).

Area (m^2)	Contamination Zone Thickness (m)	Length of Contamination Zone (m)	DU Activity Concentration (pCi g^{-1})	Years Post Deposition Dose (max)	Dose Equivalent (mrem y^{-1})
10,000	2	100	1	815	1.0
1,000	0.5	50	20	745	5.2
1,000	0.5	50	7	745	1.8
300	0.5	25	23.3	457	5.4

The depleted uranium contaminant is a Section 91b material as defined by the Atomic Energy Act of 1954. The Department of Defense (DoD) retains regulatory authority for the contaminant. For the Department of the Air Force, responsibility is delegated to Headquarters, Air Force Safety Center as provided in AF Instruction 40-201, *Managing Radioactive Materials in the Air Force*. The DoD has been directed to apply current accepted practice in maintenance and disposition of contaminated sites. Two Federal agencies have issued regulatory and proposed standards for residual radioactive materials. The Nuclear Regulatory Commission (NRC) has a risk-based regulatory standard for residual radioactive materials of 25 mrem y^{-1}, with the "as low as is reasonably achievable"

(ALARA) principle [10 Code of Federal Regulations (CFR), Part 20, Subpart E, *Radiological Criteria for License Termination,* 10 CFR 20.1402]. The Environmental Protection Agency (EPA) proposed a risk-based standard of 15 mrem y^{-1}, also with the ALARA provision (40 CFR 195, *Radiation Site Cleanup Regulations*).

The 434th ARW made the decision to remediate the site based on the ALARA principle, though the site met both NRC and EPA primary criteria. AFIERA recommended delineation of the remediation area to locations of residual DU readily differentiated from background with portable instruments (Rademacher 2000). Portable 3 x 3 NaI(Tl) detectors were estimated to be sensitive to 6.4 pCi g^{-1} of residual DU (Rademacher 2000). The IDH and EPA accepted this approach as protective of health and the ALARA principle.

4. Survey Methodology

a. General. The survey accomplished in the pre-remediation phase delineated contaminated areas from background regions using portable NaI(Tl) detection systems. Areas with low levels of depleted uranium contamination that were not readily differentiated from background radiation areas were left as residual. Based on the background assessment for the site and the measured sensitivity of NaI(Tl) detectors to depleted uranium, total excess uranium activity concentrations of 6.4 pCi g^{-1} could be discriminated from background sources of radiation (Rademacher 2000). The use of portable instruments reasonably balanced cost of contaminated waste disposal, survey time, equipment and personnel costs, and mobilization costs. Since health risks to employees was not determined to be significant, this factor was not incorporated into the evaluation. Use of portable instruments to assess soil removal requirements was highly advantageous over soil sampling and subsequent laboratory analysis because of the time lag between collection and sample analysis.

b. In-Situ Measurements. Fixed in-situ measurements were collected on a two meter (6.6 ft) grid with a NaI(Tl) detection system. For the pre-remediation survey, plans were made to accomplish the survey with a 3 x 3 NaI(Tl) detector. However, early in the grid survey, the detector fell on its side, initiating a quality assurance/quality control (QA/QC) check to ensure proper operation. The instrument failed the chi-square tests for reliability and failed to provide similar background location measurements. As a result, the instrument was removed from service and replaced with a backup 2 x 2 NaI(Tl) detector. For the RASS, a 3 x 3 NaI(Tl) detector was used for scanning and fixed measurements. Appendix A contains a listing of the survey instruments.

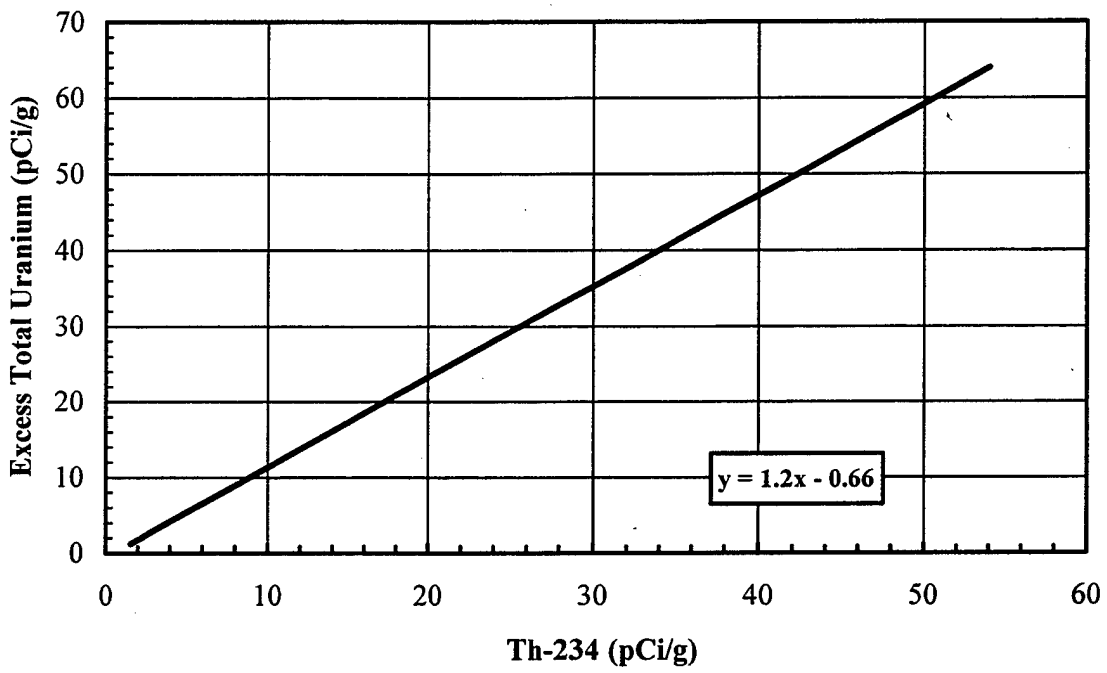
c. Soil Sampling of Remediation Zone for Waste Characterization. Based on the results of the pre-remediation survey, 10 soil samples were collected from the areas planned for remediation. The samples were analyzed for radionuclide content by γ-spectroscopy analysis. From 5 of the 10 locations, additional samples were collected for chemical analysis solely to meet disposal acceptance requirements of the waste disposal facility. Hazardous chemicals are not contaminants of concern.

d. Post-Remediation Fixed In-Situ γ-Radiation Survey. Post-remediation fixed in-situ γ–radiation surveys were accomplished with a 3 x 3 NaI(Tl) on a two meter grid in the remediation zone. Based on the results of the survey, and through consultation with the 434th Environmental Engineering Flight (434th SPTG/CEV) and IDH, an additional 30 cm (12 in) lift was removed in a small area of the remediation zone. In-situ measurements were recollected on sampling locations in the area of additional remediation.

e. Final Status Soil Sampling. A sampling grid was developed using the reference grid system implemented in the characterization study (Rademacher and Hoak 2000). The sampling grid encompassed the entire remediation area and an approximately equal area surrounding it. Twenty-five surface soil samples were collected using a triangular grid system as described in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NRC 1997). Sampling depth was approximately 15 cm (0.5 ft) with each sample comprising at least one kilogram (2.2 lbs). The samples were collected with a small shovel. Decontamination was done between each sample using detergent and distilled water. Samples were double-wrapped in plastic bags. Chain of custody was documented. To maintain chain of custody, all samples were under constant observation or secured. All sample labels were completed using waterproof ink. For 10 of the sampling locations, replicate samples were collected and packaged in a similar manner and sent to Duke Engineering Services for analysis. Three replicates were collected for internal laboratory QA/QC. Samples were dried, homogenized, and analyzed through γ-spectroscopy. Estimated excess total uranium was calculated with ^{234}Th activities and the relationship as shown in Figure 5.

f. Field Contamination Control Assurance. To assure contamination was contained on the site, personnel and equipment leaving the remediation zone were screened with portable β/γ-radiation detection instruments as listed in Appendix A. A 3 x 3 NaI(Tl) was used to screen the backfilled area, the remediation support zone, and ingress/egress routes to ensure no contaminated soil was spread on the site.

Figure 5. Excess Activity Concentration of Excess Total Uranium vs. Measured ^{234}Th for Background Total Uranium = 1.1 pCi g^{-1} and a Depleted Uranium Contaminant.



g. Survey Personnel. Tables 3a and 3b contain a listing of survey personnel.

Table 3a. Survey Team Personnel (Pre-Remediation Survey).

Name	Position	Organization
Major Steven Rademacher	AFIERA Survey Chief	AFIERA/SDR, Brooks AFB TX
Mr. Brian Renaghan	Health Physicist	AFIERA/SDRH, Brooks AFB TX
SSgt Darrin Lawrence	Radioanalytical Technician/Sample Control	AFIERA/SDRD, Brooks AFB TX

Table 3b. Survey Team Personnel (Remediation Surveys).

Name	Position	Organization
Mr. Rex Bowser	Radiation Safety Inspector	Indiana Dept. of Health
Major Steven Rademacher	AFIERA Survey Chief	AFIERA/SDR, Brooks AFB TX
Mr. Brian Renaghan	Health Physicist	AFIERA/SDRH, Brooks AFB TX
SrA Kimberly Murchison	Bioenvironmental Engineering Technician	AFIERA/SDRH, Brooks AFB TX

5. Pre-Remediation Survey Results

a. General. The pre-remediation survey was accomplished 1 August 2000. The grid system implemented in the characterization survey was recreated by locating the hot-spot and using a transit to align the grid. The 3 x 3 NaI(Tl) detector prepared for measurements fell and was removed from service. The 2 x 2 NaI(Tl) backup probe was used. Instrument background, QA/QC, and hot-spot measurements with this instrument are contained in Table B-1 of Appendix B. Fifteen background locations were marked in an area more than 50 m (160 ft) from the contamination zone. Ten measurements were taken at background location #1 to assess detection system reliability. Summary statistics of the background measurements are contained in Table B-2. For pre- and post-survey measurements at background location #1, the instrument was assessed to be reliable due to the close agreement in mean count rate of each data set (RPD = 1.6 %) and the calculated percent coefficient of variation (% CV) of each data set with the theoretical expectation of about 1.6 %.

b. Grid Measurements. Grid measurements were collected every two meters, with the detector to ground surface separation of 7.5 cm (3 in). The measurements ranged from 3,524 to 5,794 counts per 30-second count period, with background at 4,097 counts. Table B-3 contains a complete listing of grid measurements. Figure B-1 provides a graphical depiction of the grid measurements. The plot, comprised of 333 measurements, provides more detail than that of the characterization survey (Figure 4) but is consistent with previously identified contaminated areas.

c. Correlation Coefficients. Correlation between the grid measurements of this survey and that of the characterization survey was assessed to determine relative sensitivity of the 2 x 2 NaI(Tl) and 3 x 3 NaI(Tl). Figure B-2 contains a scatterplot of the data for paired grid measurements. The slope of the regression analysis is 0.187. Modified to account for the different integration times, the slope is 0.374, with the 3 x 3 NaI(Tl) being 2.67 times more efficient. The squared correlation coefficient of 0.87 is reasonable, considering that some minor differences may have existed in the two grid systems and instrument response fluctuation due to ambient temperature variation.

d. Waste Profiling. Soil samples were collected uniformly within the contamination zones. The sampling was accomplished for pre-profiling the waste for eventual disposal. Figure B-3 contains a scatterplot of the soil ^{234}Th activity concentrations vs. the paired instrument measurement. The slope of the regression is 26.4 counts g pCi^{-1}, with good correlation between the two parameters, demonstrating that in-situ measurements provide good surrogates to laboratory analysis of soil

samples. Table B-4 contains the soil sampling results for ^{234}Th, ^{235}U, and ^{241}Am for the specified sampling locations. The mean ^{234}Th activity concentration among the samples was 14.2 pCi g^{-1}, with the estimated mean excess DU activity of 16 pCi g^{-1} using the relationship in Figure 5. This estimate is within the range estimated in the characterization report of 15 – 20 pCi g^{-1}. Table B-5 contains the toxicity characteristic leaching procedure (TCLP), metals, and herbicide analytical results for the five waste profiling samples. The results verify that the waste did not contain hazardous chemical contaminants that would restrict disposal as a radioactive waste.

6. Remediation Activities and Post-Remediation Survey Results

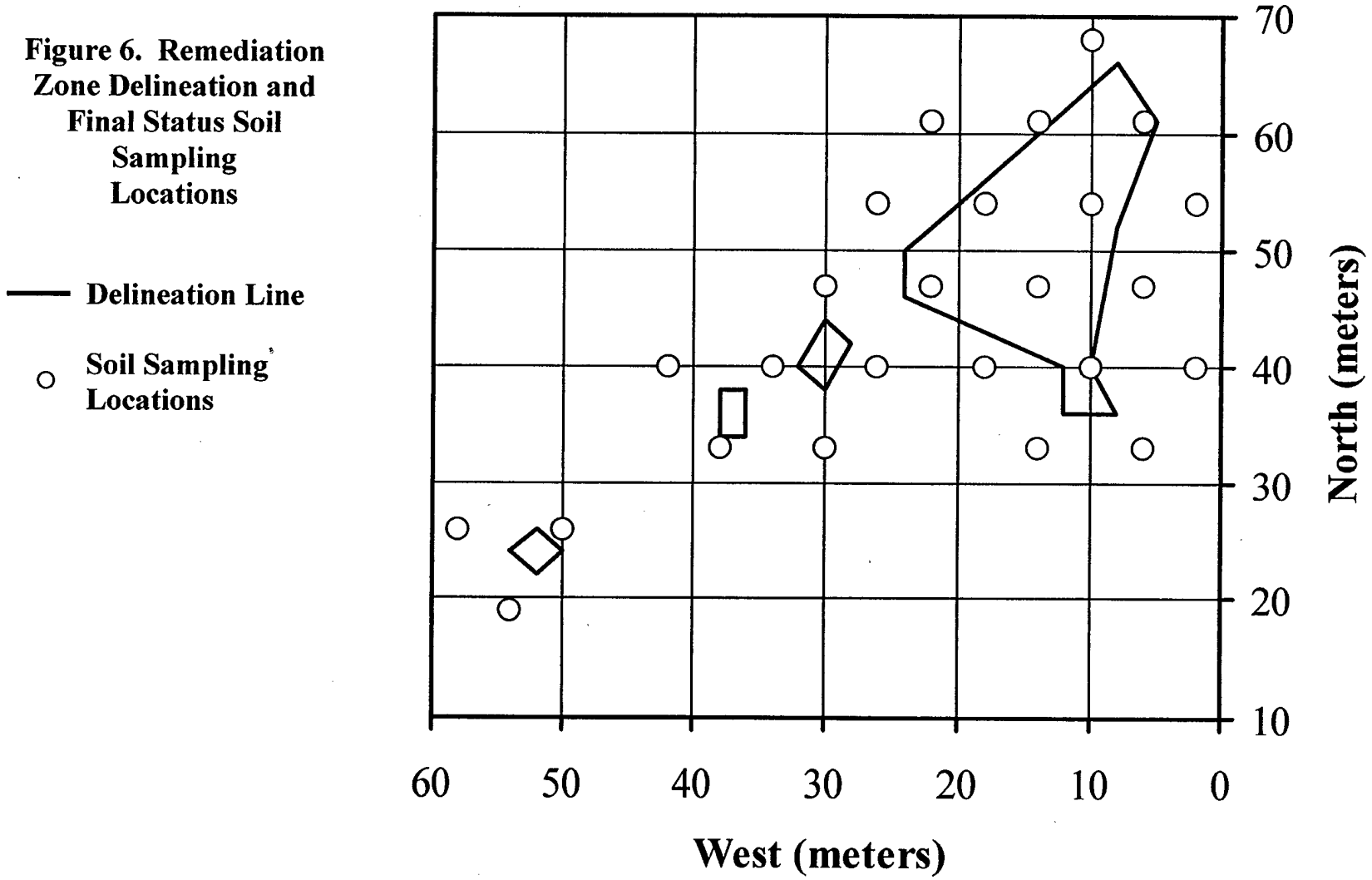
a. Remediation Zone Delineation. The remediation zone was marked 11 September 2000, the second phase of the project. Figure 6 graphically depicts the zone by the solid black line, with final site status soil sampling locations denoted by the circles. The zone was created by evaluation of Figure B-1, with respect to detector response. The upper limit of the violet contour corresponds to DU activity concentrations of about 6.4 pCi g^{-1}, based on a mean background count rate of 4,097 counts per 30-second and a detector to ^{234}Th contaminant correlation coefficient of 26 counts g pCi^{-1}.

b. Background Measurements. 3 x 3 NaI(Tl) instruments were used to collect background measurements at the same location as that of the pre-remediation survey. Multiple measurements were collected to assess instrument reliability. Background measurements were collected every day, with multiple assessments on 14 September 2000 because RASS measurements were collected. Tables C-1a – C-1j contain background measurement summaries and associated theoretical and calculated standard deviations. Based on comparisons of theoretical and calculated standard deviations, survey instruments were determined to be reliable. Measurements were also collected at the hot-spot location to verify that survey instruments had a response similar in proportion to that noted from the pre-remediation survey (Tables C-2a – C-2c).

c. First Soil Removal Operation. Soil removal operations in the delineated zone were initiated on 12 September 2000. Due to rain, removal of the top 30 cm (12 in) was not complete until 14 September. The operation filled 12 containers with a disposal volume of 87 m^3 (3,100 ft^3).

d. Remedial Action Support Survey. After the first soil removal operation, a scanning survey of the remediation areas was completed. Areas of highly elevated activity were not located during the scanning survey. The 2.0 m (6.6 ft) grid was re-established in the remediation areas.

Figure 6. Remediation Zone Delineation and Final Status Soil Sampling Locations



Fixed measurements were collected in the remediation area. For the small excavated areas, the grid had a limited number of survey points, requiring some off-grid measurements to ensure a sufficient number of locations were surveyed. In the former hot-spot area of the large excavation area, off-grid measurements were collected to more finely investigate localized contamination. Table C-3 contains a complete listing of the measurements. The 72 measurements ranged from 10,722 to 12,640 counts. For the excavated areas, measurements were expected to be slightly elevated over those measurements from the unremediated area for two reasons. First, the grass zone provides some attenuation of the photons emitted from the DU. Second, the geometry of the two measurement conditions is different. In excavated areas, a detector will have more γ–radiation entering the detector side than in level-grade areas. Overall, these two factors were estimated to increase detector response by 250 counts [30 s] in the excavated areas. A graphical display of the survey data is in Figure C-1, with the omission of data collected off the 2.0 m grid. The upper limit of the violet contour corresponds to DU contamination of about 8 pCi g^{-1}. [Note. The violet contours of Figures B-1 and C-1 represent different count ranges and estimated ^{234}Th activity concentrations.]

e. Second Soil Removal Operation. After reviewing the data in Figure C-1, Major Rademacher, Mr. Renaghan, and Mr. Bowser decided to remove another 30 cm (12 in) from the localized area of elevated contamination of the large excavation area. Appendix E contains copies of the waste shipment manifest. Some elevated measurements existed in two of the small excavated areas, but were deemed largely to be the result of geometry (i.e., a detector edge effect). It was agreed that additional remediation in these areas was unnecessary.

f. Final Site Status Survey. After the second soil removal operation was complete, the 2.0 m (6.6 ft) grid was re-established in the excavated area. Measurements were collected and are listed in Table C-4, with a listing of measurements collected prior to the second soil removal operation. Evaluation of the seven paired-measurements showed that five of the repeated measurements were lower, while two were increased. The five locations that had reduced measurements represented those locations with the highest initial measurement; leading to the conclusion that the second soil removal operation was beneficial. The two locations with an increased measurement were close to the wall of the excavation, with the increased count rate assumed to be the result of the detector edge effect. A graphical display of the final site status data is in Figure C-2. An agreement was made between Major Rademacher, Ms. Marx, and Mr. Bowser that additional soil removal was not necessary because the area with residual contamination (differentiable from background) was limited

and had an estimated activity concentration near the final screening criterion of 8 pCi g^{-1} (Rademacher 2000). Final status soil samples were then collected based on the grid in Figure 6.

g. Final Site Status Soil Sampling Results. The results of the final site status soil samples are listed in Table C-6 for ^{235}U, ^{234}Th, and ^{241}Am. For archival purposes, complete analytical results for the private laboratory are provided in Appendix D. The ^{234}Th activity concentrations are assumed to be in secular equilibrium with the parent ^{238}U and can be directly used to estimate the residual DU according to the relationship in Figure 5. The ^{235}U and ^{241}Am are listed to confirm that the soils do not contain enriched uranium and WGP contamination, respectfully. The results for ^{234}Th ranged from < 0.5 to 7.4 pCi g^{-1}, with an average of 1.7 pCi g^{-1} (under the assumption that the less than value data points were at the maximum). Using the relationship in Figure 5, the estimated average residual DU is 1.3 pCi g^{-1} (95 % confidence interval: 0.7 to 2.1 pCi g^{-1}). The ^{241}Am activity concentrations were typical for background, supporting the conclusion that WGP is not a residual soil contaminant. For all samples except GS0000276, the one with highest ^{234}Th activity concentration, the ^{235}U activity concentrations are typical for background, supporting the conclusion that enriched uranium is not a residual soil contaminant. The ^{234}Th activity concentration value of 7.4 pCi g^{-1} was the highest. It corresponds to an estimated DU activity concentration of 8.2 pCi g^{-1} and was collected in the small area of the large remediation area where final fixed γ–radiation measurements were the highest. The value of 8.2 pCi g^{-1} corresponds well to the post-remediation γ-radiation screening criterion of 8 pCi g^{-1}, validating the survey methodology. The ^{235}U activity concentration for this sample is consistent for DU and is not indicative of an enriched uranium contaminant.

7. Final Status RESRAD Calculations

RESRAD Version 5.82 (Yu *etal* 1993) was used to estimate radiological exposure conditions existing on the site, under the assumption that the site was occupied by residents that derived agricultural benefits from the land. This exposure assumption is believed to be the most restrictive (i.e., worst case exposure).

Default parameters were used for the calculations with the following site conditions: DU activity concentration = 1.3 pCi g^{-1} (isotopic mix of Table 1), contamination zone thickness = 0.3 m, contaminated area = 600 m^2, length parallel to aquifer = 24 m, and no cover over the residual contamination zone. The "no cover" assumption is conservative and provides an estimated dose

equivalent to future residents higher than that of actual site conditions. The residual contamination zone was covered with 0.5 m (1.5 ft) of clean soil.

The estimated current dose equivalent rate for the site is 0.11 mrem yr^{-1}, with about 75 % of the dose equivalent from direct external γ-radiation (ground). The maximum dose equivalent rate for the site, 0.2 mrem y^{-1}, is projected 700 y from now, with most of the dose equivalent from water pathways. The current and maximum projected dose equivalent rates for the site are respectively 136 and 75-fold lower than the EPA recommended residential dose equivalent rate of 15 mrem y^{-1} and significantly lower than that estimated before remediation (Table 2).

8. Quality Assurance/Quality Control

a. General. A number of measures were taken to ensure that the data produced could be used to adequately assess the effectiveness of the remediation and the final site status assessment.

b. Soils. Three soil sampling locations had AFIERA Radioanalytical Laboratory replicate sample analysis, while at 10 locations similar replicates were field split (split replicates) and analyzed by AFIERA and Duke Engineering Services. Table 4 contains paired replicate sample mean ^{234}Th activity concentrations, relative percent difference (RPD) values, and theoretical RPD values expressed at the 50 and 90 % confidence interval (CI). The RPD for low activity

Table 4. Calculated and Absolute Theoretical RPDs for ^{234}Th in Replicate Soil Samples.

Sample Location	Mean ^{234}Th (pCi g^{-1})	Calculated RPD	Theoretical Absolute RPD	
			50 % CI	90 % CI
26N – 50W	3.7	7	30	78
33N – 14W	0.8	73	69	255
33N – 30W	0.7	56	27	70
33N – 38W	1.6	- 19	32	86
40N – 2W	1.2	3	35	98
40N – 10W	1.6	7	16	40
40N – 26W	0.9	41	40	110
47N – 14W	4.0	15	33	83
54N – 2W	1.9	42	19	47
54N – 18W	6.6	- 23	10	24
54N – 26W	0.7	- 44	48	147
61N – 6W	3.4	4	8	21
61N – 14W	1.2	31	41	127

concentration samples was significantly higher than that of the higher activity concentration samples. For paired samples with mean ^{234}Th activity concentrations less than 1.2 pCi g^{-1}, the RPD ranged from 3 to 73 %. For samples with higher ^{234}Th activity concentration, the absolute RPD ranged from 4 to 42 %. Eight of the 13 replicates had RPD values within the 50 % CI, while all were within the 90 % CI.

c. Fixed In-Situ γ-Measurements. Ten locations had replicate in-situ measurements. The purpose of the measurements was to evaluate variability in field measurements. Table C-5 contains a summary of results. The difference values among the measurements ranged from –211 to 764, with a mean of 280 counts. The difference between the two sets of measurements is beyond that anticipated for random counting uncertainties alone (95 % confidence interval: ± 200 counts). Since the measurements were collected over a period of a few hours, and there were significant changes in ambient temperature and sun exposure during the day, the variability observed is reasonable for portable NaI(Tl) systems.

9. Conclusions

The remedial actions of the contaminated areas were accomplished according to the workplan with about 87 m^3 (3,100 ft^3) DU contaminated soils disposed at Waste Controls Specialists, LLC, a company licensed to operate a low-level radioactive waste disposal facility. Field measurements and laboratory analysis of post-remediation soil samples confirm that the goals of the remediation effort were achieved. The mean activity concentration of residual DU contaminant was estimated at about 1.3 pCi g^{-1} [95% CI: 0.7 to 2.1 pCi g^{-1}]. Calculated dose equivalent rates for hypothetical future site residents had a maximum of 0.2 mrem y^{-1}. This level is well below the 15 mrem y^{-1} criterion that was recommended by the EPA. Although the installation has no present interest in utilization of the site for other purposes, the site meets the unrestricted public use criterion with respect to radiological concerns. No further remedial actions are recommended for the site.

10. References

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Appendix A

Survey Instrumentation

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Table A. AFIERA Survey Instrumentation.

Measurement Type	Location	Instrumentation	Estimated Minimal Detectable Concentration
In-situ Gamma (scanning + fixed)	Remediation Area - 7.5 cm above surface	Eberline Model SPA-3 2 x 2 NaI (Tl) Detector w/ Ludlum 2221 Ratemeter/Scaler Ludlum Model 44-20 3 x 3 NaI (Tl) Detector w/ Ludlum 2221 Ratemeter/Scaler	20 pCi g^{-1} DU (scanning) 6.4 pCi g^{-1} DU (fixed)
Gamma Exposure Rate	Remediation Area	Ludlum Model 19 Exposure Rate SN 138433	10 μR hr^{-1}
Beta/Gamma Frisker	Remediation Area, Personnel, Equipment	Bicron Analyst SN A505P w/ Bicron PGM SN C702B Bicron Surveyor SN A809P w/ Bicron PGM SN C714B	300 dpm (Sr-90)

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Appendix B

Pre-Remediation Survey Data

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Table B-1. Instrument Background and Quality Assurance/Quality Control Measurements.

Location	Counts (30 s)	Time	High Voltage	Battery (V)
Background #1	4,046	1240	759	6.1
Background #1	4,010			
Background #1	4,079			
Background #1	4,088			
Background #1	4,100			
Background #1	4,077			
Background #1	4,172			
Background #1	4,207			
Background #1	4,099			
Background #1	4,091			
Background #2	4,130			
Background #3	4,030			
Background #4	4,193			
Background #5	4,128			
Background #6	4,023			
Background #7	4,168			
Background #8	4,219			
Background #9	4,056			
Background #10	4,156			
Background #11	3,928			
Background #12	4,037			
Background #13	4,119			
Background #14	4,020			
Background #15	4,084			
55N – 17W	21,868	1320		
55N – 17W	22,047			
55N – 17W	21,822	1440	759	6.0
55N – 17W	21,095	1640	759	5.9
55N – 17W	21,543	1735	758	5.9
55N – 17W	22,114	1810	758	5.9

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Table B-1 (Continued). Instrument Background and Quality Assurance/Quality Control Measurements.

Location	Counts (30 s)	Time	High Voltage	Battery (V)
Background #1	3,994	1810	758	5.9
Background #1	4,002			
Background #1	4,032			
Background #1	4,102			
Background #1	4,087			
Background #1	4,010			
Background #1	3,986			
Background #1	3,943			
Background #1	4,010			
Background #1	4,147	1820		

Note: Time notation, high voltage measurement, and battery potential were collected only periodically among groups of measurements.

B1 GPS Location: 40° 39.524 (latitude) 86° 08.181 (longitude)
B1 Grid Location: 10S – 0W

Meter: Ludlum Model 2221 Ratemeter/Scaler, Serial Number 132851
Meter Settings: HV = 759 V, Threshold = 119, Window = 3692 (operated in "OUT" position)

Probe: Ludlum SPA3 2 x 2 NaI(Tl), Serial Number 408881-002

Table B-2. Statistics for QA/QC Measurements.

Measurement Group	Statistics (30 s Counting Times)		
	μ	σ	% CV
Pre-Survey Background #1	4,097	57	1.4 %
Pre-Survey Backgrounds	4,089	79	1.9 %
Post-Survey Background #1	4,031	62	1.5 %

Table B-3. Pre-Remediation Grid Measurements (30 s Counts).

Location West (m)	Location North (meters)								
	20	22	24	26	28	30	32	34	36
0									
2									
4									
6									
8									4141
10									4287
12									4035
14									4291
16									4111
18									
20									
22								4173	4220
24								4213	4253
26									4207
28									4157
30									4152
32									4114
34								4077	3978
36							3900	4320	4180
38						4001	4059	4039	4324
40			4081	4181	4121	4216	4117	4097	4099
42		4110	4231	4303	4290	4094	4233	4091	3986
44			4094	4213	4179	4193	4058	4006	3856
46	4018	4210	3947	4091	4172	4205	4165	3901	3884
48	4131	4029	3959	4082	4233	4153	3952	3770	3775
50	4154	4118	4068	4217	4218	4202	4078	3948	3762
52	3942	3907	4406	4022	3940	3864			
54		4241	4245	3997	4054	3675			
56			4091	3993	3783				
58			3675	3854					

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Table B-3 (Continued). Pre-Remediation Grid Measurements (30 s Counts).

Location	Location North (meters)								
West (m)	38	40	42	44	46	48	50	52	54
0									
2			4068	3937	4154	4102	4204	4064	4185
4			4098	4067	4210	4045	4250	4274	4042
6	4131	4168	4030	4155	4177	4056	4126	4203	4012
8	4142	4000	4184	4055	4118	4136	4163	4233	4304
10	4312	4231	4435	4163	4348	4266	4428	4326	4489
12	4301	4234	4228	4337	4270	4110	4326	4411	4981
14	4198	4155	4321	4392	4253	4401	4219	4749	5430
16	4318	4199	4122	4104	4239	4385	4343	4634	5794
18	4071	4108	4156	4316	4033	4192	4169	4666	4839
20	4093	4117	4229	4274	4287	4259	4003	4605	4194
22	4311	4099	4141	4234	4258	4440	4588	4296	3997
24	4100	4140	4097	4209	4205	4157	4182	3937	3936
26	3968	4121	4073	4018	4161	4124	4106	4028	3946
28	4172	4062	4280	4148	4094	3947	3960	3878	
30	4214	4330	4324	4140	3997	3899	4073	3995	
32	4158	4269	4129	4029	4044	4017			
34	4034	4208	4170	4167	4077	3846			
36	4308	3999	4002	3995	4013	3860			
38	4186	4035	3965	3836	3924	3781			
40	4087	3898	3854	3865	3717				
42	3794	3762	3824						
44	3812								
46	3775								
48	3645								
50	3643								
52									
54									
56									
58									

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Table B-3 (Continued). Pre-Remediation Grid Measurements (30 s Counts).

Location West (m)	Location North (meters)						
	56	58	60	62	64	66	68
0		4009	4017	4012	3933	3896	3860
2	4095	4127	4053	4139	3988	3877	3947
4	4015	4218	4257	4034	3948	3922	3859
6	4222	4218	4107	4300	4194	3861	3805
8	4246	4403	4441	4559	4329	3860	3905
10	4859	5423	4472	4287	4158	4116	4004
12	5172	4797	4283	4011	4044	3893	3671
14	5661	4195	4220	4084	3926	3803	3524
16	4545	4086	4019	4024	3943	3717	3762
18	4169	4018	3795	3979	3947	3925	
20	3861	3884	3875	3933	3802		
22	3919	3854	3833	3690			
24	3848	3769					
26	3982	3743					
28							
30							
32							
34							
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40							
42							
44							
46							
48							
50							
52							
54							
56							
58							

Figure B-1. Pre-Remediation In-Situ γ-Radiation Measurements - (n = 333).

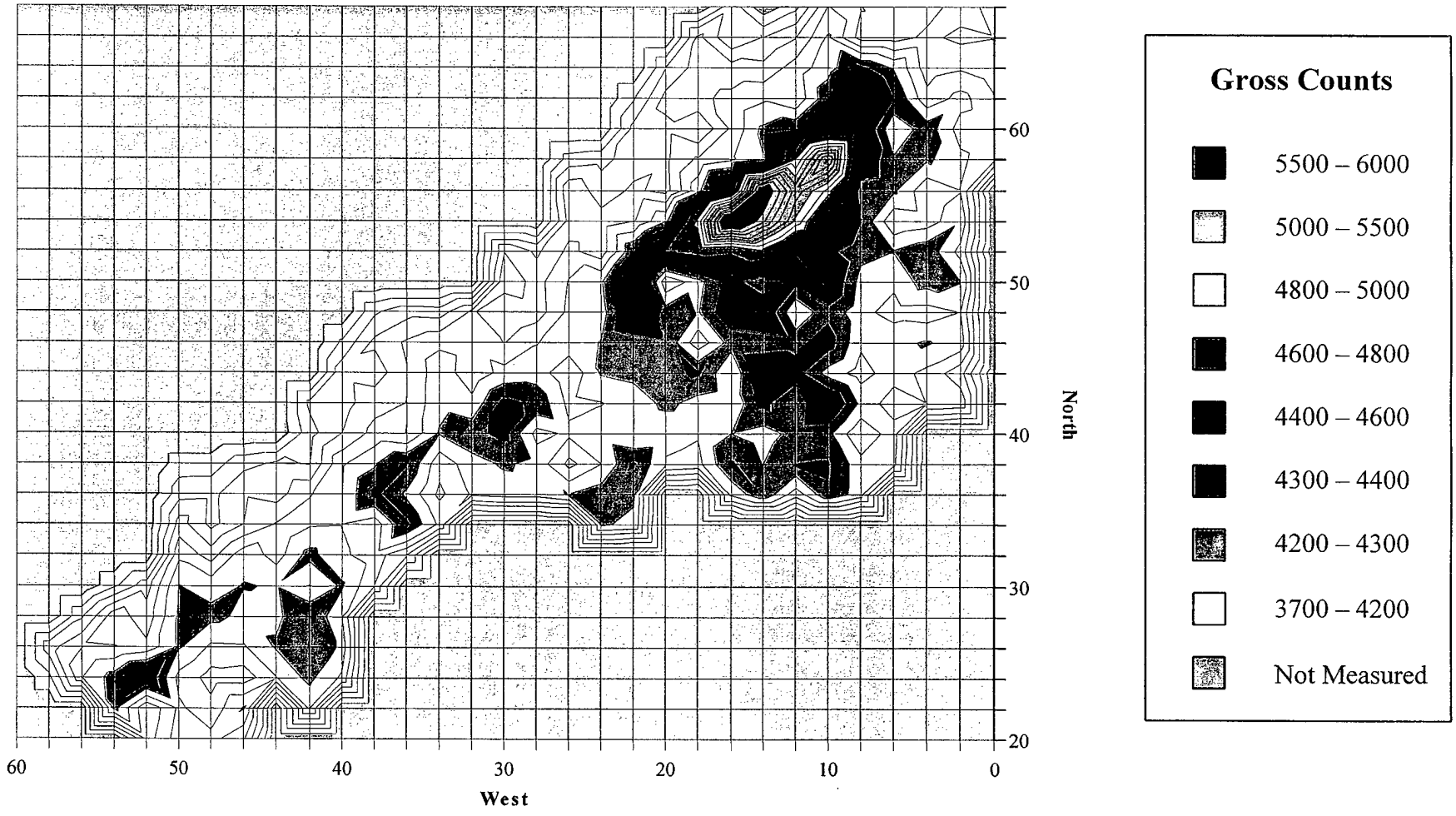

Figure B-2. Scatterplot of Characterization Survey 3 x 3 NaI(Tl) Measurements vs. Pre-Remediation Survey 2 x 2 NaI(Tl) Measurements for Paired Grid Points.

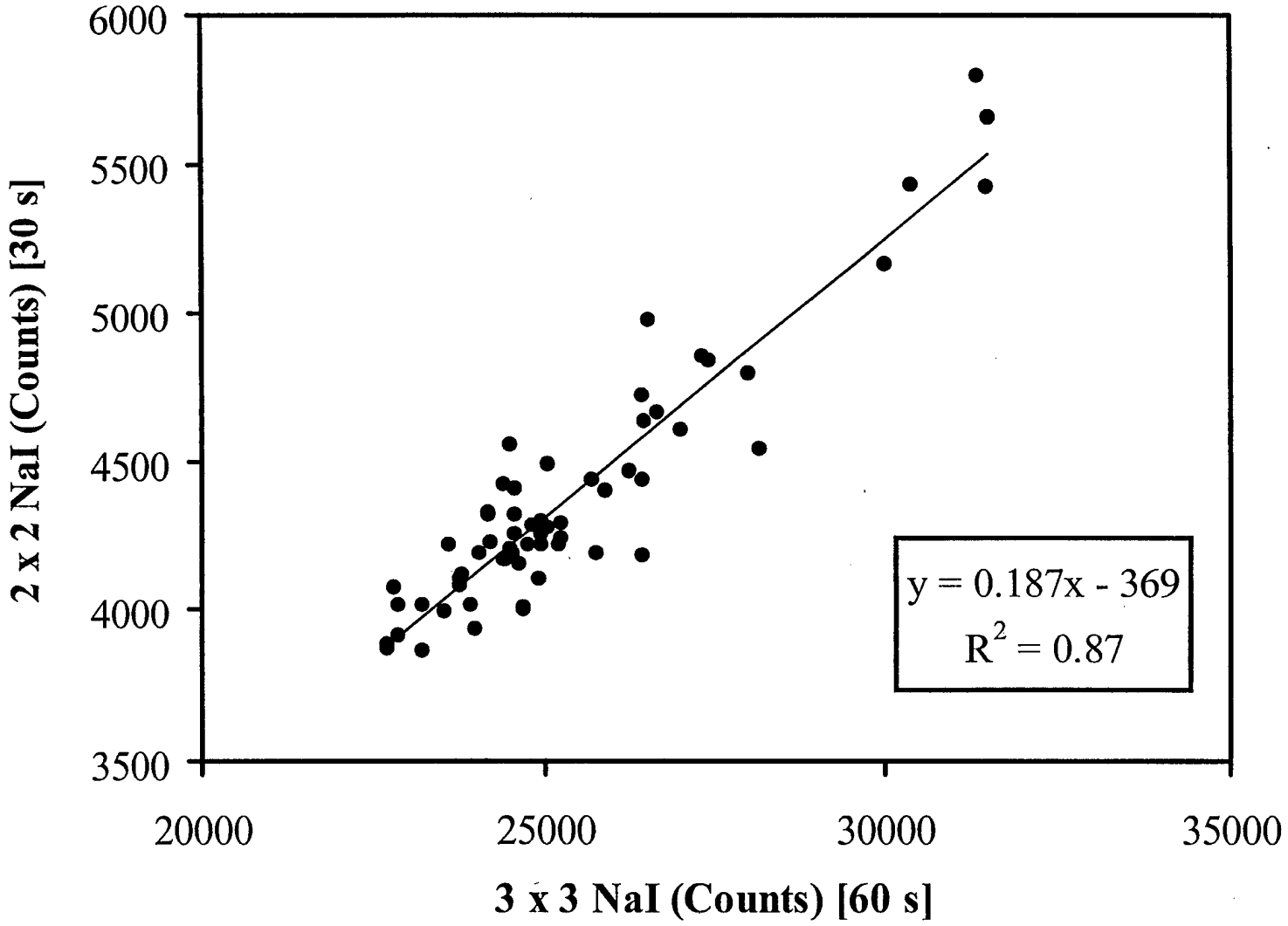

Figure B-3. Scatterplot of Pre-Remedial Action Survey 2 x 2 NaI(Tl) Measurements vs. Paired Laboratory γ-Spectroscopy Analysis for ^{234}Th.

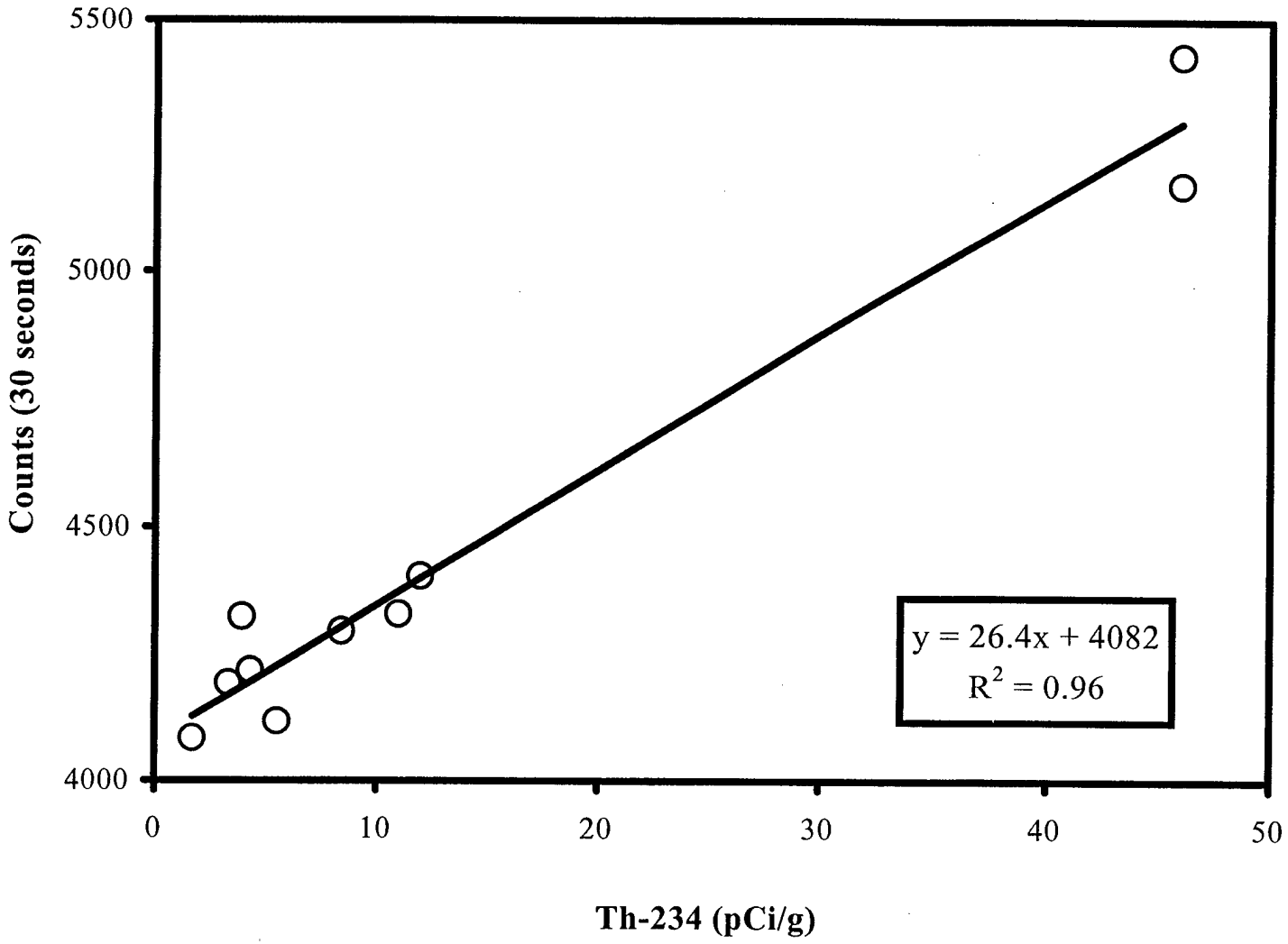

Table B-4. Pre-Remediation Soil Sample γ-Spectroscopy Results.

Sample Location	Base Sample Number	^{234}Th (pCi g^{-1})		^{235}U (pCi g^{-1})		^{241}Am (pCi g^{-1})
		Value	Uncertainty	Value	Uncertainty	
52N – 22W	GS0000552	8.4	0.9	0.27	0.14	< 0.13
42N – 30W	GS0000553	3.9	0.8	< 0.16		< 0.16
54N – 14W	GS0000554	46	3	< 0.22		< 0.2
54N – 20W	GS0000555	3.3	0.5	< 0.1		< 0.09
62N – 14W	GS0000556	1.7	0.6	< 0.09		< 0.09
40N – 20W	GS0000557	5.5	0.6	0.16	0.09	< 0.10
64N – 8W	GS0000558	10.7	0.8	0.22	0.11	< 0.11
58N – 8W	GS0000559	11.7	0.7	0.26	0.06	< 0.07
56N – 14W	GS0000560	46	2	0.81	0.10	< 0.11
50N – 14W	GS0000561	4.3	0.4	< 0.06		< 0.06
Mean		14.2*	5.7	0.2**		0.11

* Total Estimated Uranium Activity Concentration is 16.3 pCi g^{-1} [Net = 15.2 pCi g^{-1}] using assumptions of Rademacher and Hoak (2000)

** Based on Estimated Ratio of U-238 to U-235 in DU using assumptions of Rademacher and Hoak (2000)

Uncertainty Values at the 1σ Level

Table B-5. Pre-Remediation Soil Sample TCLP-Metals Results.

Analyte	EPA Method	Units	64N – 8W		52N – 38W		52N – 22W		40N – 10W		26N – 52W	
			Report Limit	Result	Report Limit	Result	Report Limit	Result	Report Limit	Result	Report Limit	Result
Arsenic	6010B	mg L^{-1}	0.25	< 0.25	0.25	< 0.25	0.25	< 0.25	0.25	< 0.25	0.25	< 0.25
Barium	6010B	mg L^{-1}	0.005	2.37	0.005	2.79	0.005	2.08	0.005	1.92	0.005	2.07
Cadmium	6010B	mg L^{-1}	0.005	<5E-3	0.005	<5E-3	0.005	<5E-3	0.005	<5E-3	0.005	<5E-3
Chromium	6010B	mg L^{-1}	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01
Lead	6010B	mg L^{-1}	0.5	<0.5	0.5	<0.5	0.5	<0.5	0.5	<0.5	0.5	<0.5
Selenium	6010B	mg L^{-1}	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1
Silver	6010B	mg L^{-1}	0.005	0.082	0.005	0.006	0.005	0.01	0.005	0.118	0.005	<5E-3
1,1-Dichloroethane	8260B	mg L^{-1}	0.7	<0.7	0.7	<0.7	0.7	<0.7	0.7	<0.7	0.7	<0.7
1,2-Dichloroethane	8260B	mg L^{-1}	0.5	<0.5	0.5	<0.5	0.5	<0.5	0.5	<0.5	0.5	<0.5
1,4-Dichloroethane	8260B	mg L^{-1}	7.5	<7.5	7.5	<7.5	7.5	<7.5	7.5	<7.5	7.5	<7.5
Benzene	8260B	mg L^{-1}	0.5	<0.5	0.5	<0.5	0.5	<0.5	0.5	<0.5	0.5	<0.5
CCl_4	8260B	mg L^{-1}	0.5	<0.5	0.5	<0.5	0.5	<0.5	0.5	<0.5	0.5	<0.5
Chlorobenzene	8260B	mg L^{-1}	100	<100	100	<100	100	<100	100	<100	100	<100
Chloroform	8260B	mg L^{-1}	6.0	<6.0	6.0	<6.0	6.0	<6.0	6.0	<6.0	6.0	<6.0
MEK	8260B	mg L^{-1}	200	<200	200	<200	200	<200	200	<200	200	<200
Tetrachloroethene	8260B	mg L^{-1}	0.7	<0.7	0.7	<0.7	0.7	<0.7	0.7	<0.7	0.7	<0.7
Trichloroethylene	8260B	mg L^{-1}	0.5	<0.5	0.5	<0.5	0.5	<0.5	0.5	<0.5	0.5	<0.5
Vinyl Chloride	8260B	mg L^{-1}	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2
2,4,5-Trichlorophenol	8270C	mg L^{-1}	400	<400	400	<400	400	<400	400	<400	400	<400
2,4,6-Trichlorophenol	8270C	mg L^{-1}	2.0	<2.0	2.0	<2.0	2.0	<2.0	2.0	<2.0	2.0	<2.0

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Table B-5. Pre-Remediation Soil Sample TCLP-Metals Results (Continued).

Analyte	EPA Method	Units	64N – 8W		52N – 38W		52N – 22W		40N – 10W		26N – 52W	
			Report Limit	Result	Report Limit	Result	Report Limit	Result	Report Limit	Result	Report Limit	Result
2,4-Dinitrotoluene	8270C	mg L^{-1}	0.13	<0.13	0.13	<0.13	0.13	<0.13	0.13	<0.13	0.13	<0.13
2-Methylphenol	8270C	mg L^{-1}	200	<200	200	<200	200	<200	200	<200	200	<200
3-+4-Methylphenol	8270C	mg L^{-1}	200	<200	200	<200	200	<200	200	<200	200	<200
Chlordane	8270C	mg L^{-1}	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03
Endrin	8270C	mg L^{-1}	0.02	<0.02	0.02	<0.02	0.02	<0.02	0.02	<0.02	0.02	<0.02
Heptachlor	8270C	mg L^{-1}	0.008	<0.01	0.008	<0.01	0.008	<0.01	0.008	<0.01	0.008	<0.01
Heptachlor Epoxide	8270C	mg L^{-1}	0.008	<0.01	0.008	<0.01	0.008	<0.01	0.008	<0.01	0.008	<0.01
Hexachlorobenzene	8270C	mg L^{-1}	0.13	<0.13	0.13	<0.13	0.13	<0.13	0.13	<0.13	0.13	<0.13
Hexachlorobutadiene	8270C	mg L^{-1}	0.5	<0.5	0.5	<0.5	0.5	<0.5	0.5	<0.5	0.5	<0.5
Hexachloroethane	8270C	mg L^{-1}	3.0	<3.0	3.0	<3.0	3.0	<3.0	3.0	<3.0	3.0	<3.0
Lindane	8270C	mg L^{-1}	0.4	<0.4	0.4	<0.4	0.4	<0.4	0.4	<0.4	0.4	<0.4
Methoxychlor	8270C	mg L^{-1}	10	<10	10	<10	10	<10	10	<10	10	<10
Nitrobenzene	8270C	mg L^{-1}	2.0	<2.0	2.0	<2.0	2.0	<2.0	2.0	<2.0	2.0	<2.0
Pentachlorophenol	8270C	mg L^{-1}	100	<100	100	<100	100	<100	100	<100	100	<100
Pyridine	8270C	mg L^{-1}	5.0	<5.0	5.0	<5.0	5.0	<5.0	5.0	<5.0	5.0	<5.0
Toxaphene	8270C	mg L^{-1}	0.5	<0.1	0.5	<0.1	0.5	<0.1	0.5	<0.1	0.5	<0.1
Reactivity Cyanide	9014	$\mu g\ G^{-1}$	1.0	<1	1.0	<1	1.0	<1	1.0	<1	1.0	<1
Reactivity Sulfide	9034	$\mu g\ G^{-1}$	12	<12	12	20	12	20	12	<12	12	<12

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Table B-5. Pre-Remediation Soil Sample TCLP-Metals Results (Continued).

Analyte	EPA Method	Units	64N – 8W		52N – 38W		52N – 22W		40N – 10W		26N – 52W	
			Report Limit	Result	Report Limit	Result	Report Limit	Result	Report Limit	Result	Report Limit	Result
Hydrogen Ion	9040B	pH		7.2	0.01	8.0	0.01	8.2	0.01	7.1	0.01	8.0
Mercury	SW7470	mg L^{-1}	5E-3	<5E-3	5 E-3	<5E-3	5 E-3	<5E-3	5 E-3	<5E-3	5 E-3	<5E-3
2,4,5-TP (Silvex)	8151A	mg L^{-1}	NA	<1.0	NA	<1.0	NA	<1.0	NA	<1.0	NA	<1.0
2,4-D	8151A	mg L^{-1}	NA	<10	NA	<10	NA	<10	NA	<10	NA	<10

Appendix C

Remediation Phase Survey Data

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Table C-1a. Instrument Background and Quality Assurance/Quality Control Measurements [3 x 3 NaI - #1] (11 September 2000).

Location	Counts (30 s)	Time	High Voltage	Battery (V)
Background #1	10,016	1300	863	5.9
Background #2	9,881			
Background #3	9,856			
Background #4	9,943			
Background #5	9,855			
Background #6	10,040			
Background #7	10,067			
Background #8	9,895			
Background #9	9,947			
Background #10	10,023			
Background #11	9,860			
Background #12	10,036			
Background #13	9,858			
Background #14	9,825			
Background #15	9,843			
Background #16	9,908			
Background #17	9,967			
Background #18	10,023			
Background #19	9,818			
Background #20	9,749	1330	863	5.9

Note: Time notation, high voltage measurement, and battery potential were collected only periodically among groups of measurements.

B1 GPS Location: 40° 39.524 (latitude) 86° 08.181 (longitude) B1 Grid Location: 10S – 0W

Meter: Ludlum Model 2221 Ratemeter/Scaler, Serial Number 97810
Meter Settings: HV = 863 V, Threshold = 102, Window = 3840 (operated in "OUT" position)

Probe: Ludlum 44-20 3 x 3 NaI(Tl), Serial Number 171221 Calibrated: 8 Sep 00

Mean Background Response: 9,920.5 counts
Standard Deviation of Measurements: 90.6 counts
% CV: 0.9 %
Expected Standard Deviation: 99.6

Table C-1b. Instrument Background and Quality Assurance/Quality Control Measurements [3 x 3 NaI - #2] (11 September 2000).

Location	Counts (30 s)	Time	High Voltage	Battery (V)
Background #1	10,031	1300	742	5.9
Background #2	9,897			
Background #3	9,940			
Background #4	9,820			
Background #5	9,771			
Background #6	9,924			
Background #7	9,989			
Background #8	10,046			
Background #9	9,862			
Background #10	9,862			
Background #11	9,932			
Background #12	9,880			
Background #13	9,716			
Background #14	10,011			
Background #15	9,792			
Background #16	9,753			
Background #17	9,938			
Background #18	9,879			
Background #19	9,949			
Background #20	10,008	1330	742	5.9

Note: Time notation, high voltage measurement, and battery potential were collected only periodically among groups of measurements.

B1 GPS Location: 40° 39.524 (latitude) 86° 08.181 (longitude) B1 Grid Location: 10S – 0W

Meter: Ludlum Model 2221 Ratemeter/Scaler, Serial Number 132849
Meter Settings: HV = 742 V, Threshold = 102, Window = 3840 (operated in "OUT" position)

Probe: Ludlum 44-20 3 x 3 NaI(Tl), Serial Number 165386 Calibrated: 8 Sep 00

Mean Background Response: 9,900.0 counts
Standard Deviation of Measurements: 95.0 counts
% CV: 0.96 %
Expected Standard Deviation: 99.5

Table C-1c. Instrument Background and Quality Assurance/Quality Control Measurements [3 x 3 NaI - #1] (12 September 2000).

Location	Counts (30 s)	Time	High Voltage	Battery (V)
Background #1	10,019	0935	867	6.0
Background #2	9,885			
Background #3	9,848			
Background #4	9,935			
Background #5	9,960			
Background #6	9,648			
Background #7	9,874			
Background #8	9,847			
Background #9	9,979			
Background #10	9,958			
Background #11	9,851			
Background #12	9,865			
Background #13	10,120			
Background #14	10,077			
Background #15	9,901			
Background #16	9,760			
Background #17	9,933			
Background #18	9,743			
Background #19	9,892			
Background #20	9,899	1000	867	6.0

Note: Time notation, high voltage measurement, and battery potential were collected only periodically among groups of measurements.

B1 GPS Location: 40° 39.524 (latitude) 86° 08.181 (longitude) B1 Grid Location: 10S – 0W

Meter: Ludlum Model 2221 Ratemeter/Scaler, Serial Number 97810
Meter Settings: HV = 863 V, Threshold = 103, Window = 3851 (operated in "OUT" position)

Probe: Ludlum 44-20 3 x 3 NaI(Tl), Serial Number 171221 Calibrated: 8 Sep 00

Mean Background Response: 9,899.7 counts
Standard Deviation of Measurements: 109.4 counts
% CV: 1.1 %
Expected Standard Deviation: 99.5 counts

Table C-1d. Instrument Background and Quality Assurance/Quality Control Measurements [3 x 3 NaI - #2] (12 September 2000).

Location	Counts (30 s)	Time	High Voltage	Battery (V)
Background #1	9,789	0935	743	5.8
Background #2	9,587			
Background #3	9,765			
Background #4	9,741			
Background #5	9,842			
Background #6	9,669			
Background #7	9,903			
Background #8	9,763			
Background #9	9,794			
Background #10	9,825			
Background #11	9,613			
Background #12	9,908			
Background #13	9,761			
Background #14	9,818			
Background #15	9,862			
Background #16	9,687			
Background #17	9,911			
Background #18	9,586			
Background #19	9,889			
Background #20	9,750	1000	743	5.8

Note: Time notation, high voltage measurement, and battery potential were collected only periodically among groups of measurements.

B1 GPS Location: 40° 39.524 (latitude) 86° 08.181 (longitude) B1 Grid Location: 10S – 0W

Meter: Ludlum Model 2221 Ratemeter/Scaler, Serial Number 132849
Meter Settings: HV = 743 V, Threshold = 101, Window = 3874 (operated in "OUT" position)

Probe: Ludlum 44-20 3 x 3 NaI(Tl), Serial Number 165386 Calibrated: 8 Sep 00

Mean Background Response: 9,773.2 counts
Standard Deviation of Measurements: 102.8 counts
% CV: 1.05 %
Expected Standard Deviation: 98.9 counts

Table C-1e. Instrument Background and Quality Assurance/Quality Control Measurements [3 x 3 NaI - #1] (14 September 2000).

Location	Counts (30 s)	Time	High Voltage	Battery (V)
Background #1	10,973	1100	869	5.9
Background #2	10,842			
Background #3	11,011			
Background #4	10,969			
Background #5	10,797			
Background #6	10,867			
Background #7	10,827			
Background #8	11,130			
Background #9	10,976			
Background #10	11,024			
Background #11	10,798			
Background #12	11,019			
Background #13	11,173			
Background #14	11,035			
Background #15	10,740			
Background #16	10,977			
Background #17	10,781			
Background #18	10,941			
Background #19	11,118			

Note: Time notation, high voltage measurement, and battery potential were collected only periodically among groups of measurements.

B1 GPS Location: 40° 39.524 (latitude) 86° 08.181 (longitude) B1 Grid Location: 10S – 0W

Meter: Ludlum Model 2221 Ratemeter/Scaler, Serial Number 97810
Meter Settings: HV = 869 V, Threshold = 103, Window = 3851 (operated in "OUT" position)

Probe: Ludlum 44-20 3 x 3 NaI(Tl), Serial Number 171221 Calibrated: 8 Sep 00

Mean Background Response: 10,947 counts
Standard Deviation of Measurements: 126 counts
% CV: 1.2 %
Expected Standard Deviation: 105 counts

Table C-1f. Instrument Background and Quality Assurance/Quality Control Measurements [3 x 3 NaI - #1] (13 September 2000).

Location	Counts (30 s)	Time	High Voltage	Battery (V)
Background #1	10,131	1305	868	5.8
Background #2	10,087			
Background #3	10,087			
Background #4	10,007			
Background #5	10,133			
Background #6	10,266			

Note: Time notation, high voltage measurement, and battery potential were collected only periodically among groups of measurements.

B1 GPS Location: 40° 39.524 (latitude) 86° 08.181 (longitude) B1 Grid Location: 10S – 0W

Meter: Ludlum Model 2221 Ratemeter/Scaler, Serial Number 97810
Meter Settings: HV = 868 V, Threshold = 103, Window = 3848 (operated in "OUT" position)

Probe: Ludlum 44-20 3 x 3 NaI(Tl), Serial Number 171221 Calibrated: 8 Sep 00

Mean Background Response: 10,125 counts
Standard Deviation of Measurements: 94 counts
% CV: 0.93 %
Expected Standard Deviation: 101 counts

Table C-1g. Instrument Background and Quality Assurance/Quality Control Measurements [3 x 3 NaI - #1] (14 September 2000).

Location	Counts (30 s)	Time	High Voltage	Battery (V)
Background #1	11,168	1420	868	5.8
Background #2	11,142			
Background #3	10,861			
Background #4	10,953			
Background #5	11,097			
Background #6	11,139			
Background #7	11,018			
Background #8	10,930			
Background #9	10,915			
Background #10	10,799			
Background #11	10,934			
Background #12	10,957			
Background #13	10,899			
Background #14	10,852			
Background #15	10,832			
Background #16	10,965			
Background #17	10,889			
Background #18	10,645			
Background #19	10,845			
Background #20	10,644			

Note: Time notation, high voltage measurement, and battery potential were collected only periodically among groups of measurements.

B1 GPS Location: 40° 39.524 (latitude) 86° 08.181 (longitude) B1 Grid Location: 10S – 0W

Meter: Ludlum Model 2221 Ratemeter/Scaler, Serial Number 97810
Meter Settings: HV = 868 V, Threshold = 102, Window = 3845 (operated in "OUT" position)

Probe: Ludlum 44-20 3 x 3 NaI(Tl), Serial Number 171221 Calibrated: 8 Sep 00

Mean Background Response:	10,923 counts
Standard Deviation of Measurements:	145 counts
% CV:	1.3 %
Expected Standard Deviation:	105 counts

Table C-1h. Instrument Background and Quality Assurance/Quality Control Measurements [3 x 3 NaI - #1] (14 September 2000).

Location	Counts (30 s)	Time	High Voltage	Battery (V)
Background #1	10,607	1600	869	5.8
Background #2	10,525			
Background #3	10,663			
Background #4	10,493			
Background #5	10,469			

Note: Time notation, high voltage measurement, and battery potential were collected only periodically among groups of measurements.

B1 GPS Location: 40° 39.524 (latitude) 86° 08.181 (longitude) B1 Grid Location: 10S – 0W

Meter: Ludlum Model 2221 Ratemeter/Scaler, Serial Number 97810
Meter Settings: HV = 869 V, Threshold = 102, Window = 3845 (operated in "OUT" position)

Probe: Ludlum 44-20 3 x 3 NaI(Tl), Serial Number 171221 Calibrated: 8 Sep 00

Mean Background Response: 10,571 counts
Standard Deviation of Measurements: 119 counts
% CV: 1.1 %
Expected Standard Deviation: 103 counts

Table C-1i. Instrument Background and Quality Assurance/Quality Control Measurements [3 x 3 NaI - #1] (14 September 2000).

Location	Counts (30 s)	Time	High Voltage	Battery (V)
Background #1	10,340	1620	869	5.8
Background #2	10,275			
Background #3	10,310			
Background #4	10,520			
Background #5	10,490			
Background #6	10,231			
Background #7	10,353			
Background #8	10,306			
Background #9	10,235			
Background #10	10,226			
Background #11	10,087			
Background #12	10,150			
Background #13	10,336			
Background #14	10,018	1635	869	5.8

Note: Time notation, high voltage measurement, and battery potential were collected only periodically among groups of measurements.

B1 GPS Location: 40° 39.524 (latitude) 86° 08.181 (longitude) B1 Grid Location: 10S – 0W

Meter: Ludlum Model 2221 Ratemeter/Scaler, Serial Number 97810
Meter Settings: HV = 863 V, Threshold = 103, Window = 3848 (operated in "OUT" position)

Probe: Ludlum 44-20 3 x 3 NaI(Tl), Serial Number 171221 Calibrated: 8 Sep 00

Mean Background Response: 10,277 counts
Standard Deviation of Measurements: 137 counts
% CV: 1.3 %
Expected Standard Deviation: 101 counts

Table C-1j. Instrument Background and Quality Assurance/Quality Control Measurements [3 x 3 NaI - #1] (15 September 2000).

Location	Counts (30 s)	Time	High Voltage	Battery (V)
Background #1	10,001	1410	869	5.6
Background #2	10,100			
Background #3	10,123			
Background #4	10,049			
Background #5	10,114			
Former Hot-Spot	10,995	Area Where Formerly the Highest In-Situ γ-Radiation Measurements and Soil Sampling Results were Obtained.		
Former Hot-Spot	11,101			
Former Hot-Spot	11,094			
Former Hot-Spot	10,949			
Former Hot-Spot	11,036			
Former Hot-Spot	11,145			
Background #1	10,124			
Background #2	10,114			
Background #3	10,096			
Background #4	10,099			
Background #5	10,084	1630	868	5.6

Note: Time notation, high voltage measurement, and battery potential were collected only periodically among groups of measurements.

B1 GPS Location: 40° 39.524 (latitude) 86° 08.181 (longitude) B1 Grid Location: 10S – 0W

Meter: Ludlum Model 2221 Ratemeter/Scaler, Serial Number 97810
Meter Settings: HV = 868 V, Threshold = 103, Window = 3848 (operated in "OUT" position)

Probe: Ludlum 44-20 3 x 3 NaI(Tl), Serial Number 171221 Calibrated: 8 Sep 00

	Before	After
Mean Background Response:	10,077 counts	10,103 counts
Standard Deviation of Measurements:	51 counts	16 counts
% CV:	0.5 %	0.15 %
Expected Standard Deviation:	100 counts	101 counts

Mean Former Hot-Spot Area: 11,053 counts
Standard Deviation of Measurements: 73 counts
% CV: 0.7 %

Table C-2a. In-Situ Grid Measurements [3 x 3 NaI - #1] (11 September 2000).

Location	Counts (30 s)	Time	High Voltage	Battery (V)
55N-17W #1	45,481	1330	861	5.9
55N-17W #2	44,874			
55N-17W #3	45,003			
55N-17W #4	44,969			
55N-17W #5	44,647	Mean = 44,995 (% CV = 0.68 %)		

Table C-2b. In-Situ Grid Measurements [3 x 3 NaI - #2] (11 September 2000).

Location	Counts (30 s)	Time	High Voltage	Battery (V)
55N-17W #1	50,903	1330	740	5.8
55N-17W #2	50,709			
55N-17W #3	50,251			
55N-17W #4	50,316			
55N-17W #5	50,850	Mean = 50,606 (% CV = 0.60 %)		

Table C-2c. In-Situ Grid Measurements [3 x 3 NaI - #1] (11 September 2000).

Location	Counts (30 s)	Time	High Voltage	Battery (V)
50N-10W	10,330	1400	861	5.9
60N-10W	10,734			
50N-20W	10,047			
40N-30W	10,413			
23N-52W	10,350			

Note: Time notation, high voltage measurement, and battery potential were collected only periodically among groups of measurements.

Table C-3. Post-Remediation (1st Lift) Grid Measurements (30 s Counts). [3 x 3 NaI - #1]

Location West (m)	Location North (meters)								
	23	36	38	40	42	44	46	48	50
10					11146*	10976**	11478**	11191	10836
12			10920	10841	10910	11100	10765	10802	11141
14					11027	10980	11070	10896	10836
16					10862**	11023	11167	11164	10993
18						10809	10962	11478	11107
20						11264**	11447	11427	11565
22							11337	11380	12640**
28					12265*				
30				11392	11629				
32				11608*					
37		11662							
52	11555								

Location West (m)	Location North (meters)								
	52	53	54	55	56	58	60	62	64
6			11166				11331*	11594*	
8			11366		11230**	10946	11063	11131	10995*
10	11150		10909		11073	10849	10722	10998**	
12	10872		11578		11309	11339	10973		
14	11020		12263		11664	10804			
16	11016	11638		12489	11548				
18	11736	11834		11810					
20	11840								
24	12000*								

* Measurement within 30 cm of excavation edge

** Measurement within 100 cm of excavation edge

Table C-4. Post-Remediation (2nd Lift) Grid Measurements (30 s Counts). [3 x 3 NaI - #1]

Grid Location (meters)		1st Lift (Counts)	2nd Lift (Counts)	Difference (Counts)
N-S	E-W			
50N	22W	12,640	11,820	- 820
52N	20W	11,840	11,680	- 160
52N	18W	11,736	11,465	- 271
54N	18W	12,263	11,864	- 399
54N	16W	11,578	11,499	- 79
56N	16W	11,548	11,728	180
54N	14W	10,909	11,085	176

Table C-5. Post-Remediation (1st Lift) Field Replicate Grid Measurements (30 s Counts) [3 x 3 NaI - #1]

Grid Location (meters)		1st	Replicate	Difference
N-S	E-W	Measurement (Counts)		
48N	12W	10,802	11,427	625
50N	14W	10,836	11,600	764
56N	14W	11,664	11,982	318
52N	18W	11,736	11,969	233
48N	18W	11,478	11,714	236
44N	18W	10,809	11,282	473
46N	22W	11,337	11,213	- 124
60N	8W	11,063	11,598	535
40N	30W	11,392	11,340	- 52
36N	37W	11,662	11,451	- 211
			Mean Difference	280
			Standard Deviation	329

Table C-6. Post-Remediation Soil Sample γ-Spectroscopy Results.

Sample Location	Base Sample Number	^{234}Th (pCi g^{-1})		^{235}U (pCi g^{-1})		^{241}Am (pCi g^{-1})
		Value	Uncertainty	Value	Uncertainty	
19N – 54W	GS0000705	1.3	0.2	< 0.03	NA	< 0.06
26N – 50W	GS0000706	3.6	0.3	< 0.03	NA	< 0.07
26N – 50W	Duke-G56036	3.9	0.7	< 0.04	NA	0.13 ± 0.08
26N – 58W	GS0000707	0.6	0.2	< 0.03	NA	< 0.06
33N – 6W	GS0000708	0.8	0.2	< 0.03	NA	< 0.06
33N – 14W	GS0000709	< 0.51		< 0.03	NA	< 0.06
33N – 14W	Duke-G56037	1.1	0.5	0.08	0.10	0.04 ± 0.07
33N – 30W	GS0000710	0.5	0.2	< 0.03	NA	< 0.06
33N – 30W	GS0000711	0.8	0.2	0.11	0.01	< 0.06
33N – 38W	GS0000712	1.7	0.2	< 0.03	NA	< 0.06
33N – 38W	Duke-G56038	1.4	0.7	0.09	0.09	0.16 ± 0.06
40N – 2W	GS0000713	1.2	0.2	< 0.03	NA	< 0.06
40N – 2W	Duke-G56039	1.2	0.6	< 0.03	NA	0.06 ± 0.09
40N – 10W	GS0000714	1.7	0.2	< 0.03	NA	< 0.06
40N – 10W	GS0000715	1.6	0.2	< 0.03	NA	< 0.04
40N – 18W	GS0000716	1.3	0.2	< 0.03	NA	< 0.03
40N – 26W	GS0000717	0.7	0.2	< 0.03	NA	< 0.03
40N – 26W	Duke-G56040	1.1	0.5	< 0.03	NA	< 0.03
40N – 34W	GS0000718	1.7	0.2	< 0.03	NA	< 0.04
40N – 42W	GS0000719	0.8	0.2	< 0.03	NA	< 0.03
47N – 6W	GS0000720	1.6	0.2	< 0.03	NA	< 0.04
47N – 14W	GS0000721	3.7	0.3	< 0.03	NA	< 0.04
47N – 14W	Duke-G56041	4.3	0.3	0.07	0.09	< 0.02
47N – 22W	GS0000722	1.7	0.2	< 0.03	NA	< 0.04
47N – 30W	GS0000723	1.1	0.2	< 0.03	NA	< 0.03
54N – 2W	GS0000724	1.5	0.2	< 0.03	NA	< 0.04
54N – 2W	Duke-G56042	2.3	0.5	0.12	0.08	0.27 ± 0.11
54N – 10W	GS0000725	0.9	0.2	< 0.03	NA	< 0.04
54N – 18W	GS0000726	7.4	0.5	0.24	0.06	< 0.05
54N – 18W	Duke-G56043	5.9	0.8	0.25	0.10	< 0.07
54N – 26W	GS0000727	0.9	0.2	< 0.03	NA	< 0.04
54N – 26W	Duke-G56044	0.6	0.5	< 0.03	NA	0.03 ± 0.08
61N – 6W	GS0000728	3.5	0.3	< 0.04	NA	< 0.04
61N – 6W	GS0000729	3.4	0.3	< 0.03	NA	< 0.04
61N – 14W	GS0000730	1.0	0.2	< 0.03	NA	< 0.04
61N – 14W	Duke-G56045	1.3	0.7	0.07	0.09	0.05 ± 0.06
61N – 22W	GS0000731	0.9	0.2	< 0.03	NA	< 0.04
68N – 10W	GS0000732	0.7	0.2	0.12	0.09	< 0.04

Uncertainty Values at the 1σ Level Cells Highlighted and Combined Indicate Replicates NA = Not Applicable

Figure C-1. Post-Remediation In-Situ γ-Radiation Measurements (1st Lift) - (n = 66).

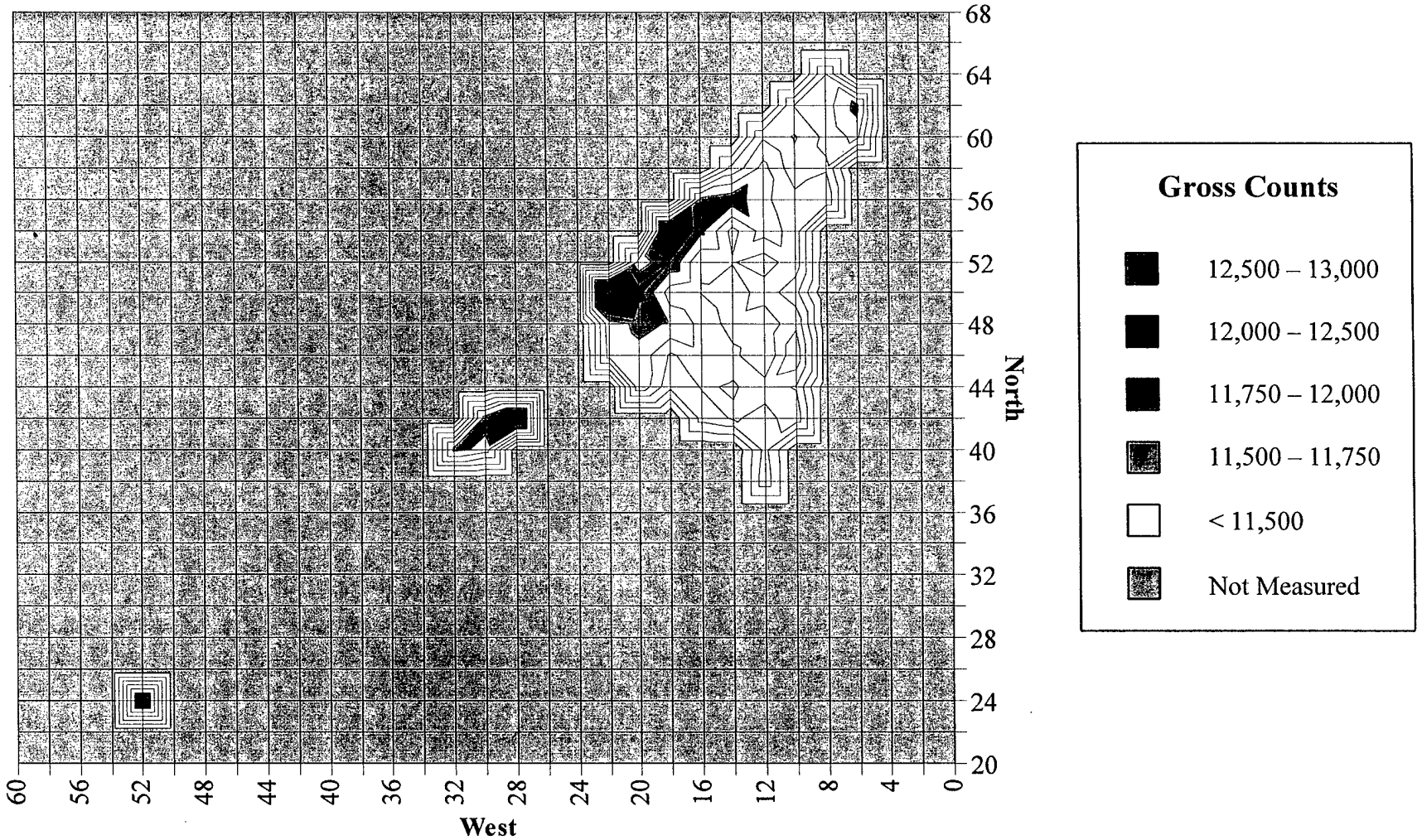
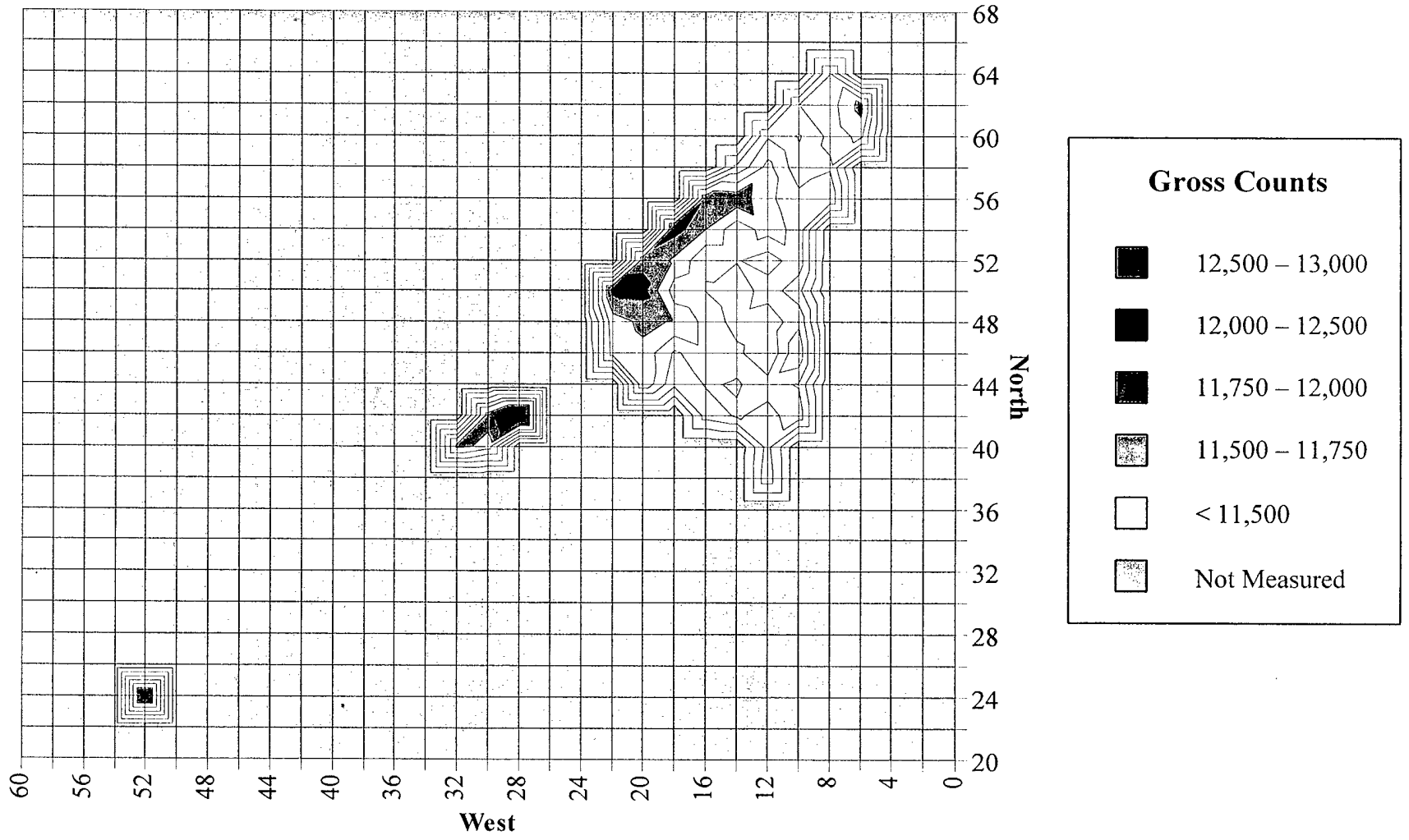


Figure C-2. Post-Remediation In-Situ γ-Radiation Measurements (2nd Lift) - (n = 66).



Appendix D

Complete Private Third-Party (Duke Engineering Services) γ-Spectroscopy Analysis Results

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DUKE ENGINEERING AND SERVICES
ENVIRONMENTAL LABORATORY

Analysis Report

Customer: Brooks AFB
Attention: Tsgt. Karen Glaken

Report Date: 10/19/00
Analysis Date: 10/03/00
Receipt Date: 09/19/00
Reference Date: 09/14/00

Soil

Station No: 28 A26W A54N

Sample Amount: 1.410 kg
Elapsed Time: 19.0417 days
Comment:

Lab Sample #: G56044
Sample Code: ZTS 28 3700
Analyses Req: G

	Nuclide	Decay Correction	Activity Conc. ± σ [picoCurie/ kg-dry]	MDC
	xNp-239	———	———	———
	Co-57	9.52E-01	(22 ± 10)E 00	33E 00
	Ce-144	9.54E-01	(32 ± 80)E 00	27E 01
	Ce-141	6.66E-01	(29 ± 26)E 00	87E 00
	xMo-99	———	———	———
	Se-75	8.95E-01	(16 ± 16)E 00	53E 00
	Cr-51	6.21E-01	(-10 ± 15)E 01	52E 01
	I-131	1.93E-01	(-4 ± 53)E 00	19E 01
	Be-7	7.81E-01	(20 ± 11)E 01	36E 01
	Ru-103	7.14E-01	(7 ± 14)E 00	47E 00
	xI-133	———	———	———
	Ba-140	3.56E-01	(-9 ± 11)E 01	40E 01
	Cs-134	9.82E-01	(-64 ± 89)E-01	42E 00
	Ru-106	9.64E-01	(26 ± 98)E 00	34E 01
+*	Cs-137	9.98E-01	(529 ± 30)E 00	58E 00
	Ag-110M	9.48E-01	(-26 ± 15)E 00	59E 00
	Zr-95	8.13E-01	(2 ± 20)E 00	73E 00
	Co-58	8.29E-01	(-19 ± 11)E 00	43E 00
	Mn-54	9.58E-01	(4 ± 12)E 00	42E 00
+*	AcTh228	1.00E 00	(902 ± 50)E 00	15E 01
	TeI-132	1.74E-02	(-10 ± 13)E 02	45E 02
	Fe-59	7.43E-01	(-19 ± 42)E 00	16E 01
	Zn-65	9.47E-01	(-45 ± 57)E 00	20E 01
	Co-60	9.93E-01	(3 ± 12)E 00	43E 00
+*	K-40	1.00E 00	(1363 ± 49)E 01	36E 01
	Sb-124	8.03E-01	(5 ± 17)E 00	68E 00
	U-235	1.00E 00	(-37 ± 83)E 00	29E+01
	Th-234	1.00E 00	(57 ± 46)E+01	15E+02
	Am-241	1.00E 00	(32 ± 78)E+00	27E+01

Notes:
* Activity greater than 3 standard deviations
+ Peak is found
x Decay correction is less than .01

Reporting level ratio: 0.000

Approved by

J. M. Raimondi 10/19/00
J. M. Raimondi

DUKE ENGINEERING AND SERVICES
ENVIRONMENTAL LABORATORY

Analysis Report

Customer: Brooks AFB
Attention: Tsgt. Karen Glacken

Report Date: 10/19/00
Analysis Date: 10/03/00
Receipt Date: 09/19/00
Reference Date: 09/14/00

Soil

Station No: 29 A14W A61N

Sample Amount: 0.504 kg
Elapsed Time: 19.0442 days
Comment:

Lab Sample #: G56045
Sample Code: ZTS 29 3700
Analyses Req: G

	Nuclide	Decay Correction	Activity Conc. ± σ [picoCurie/ kg-dry]	MDC
	xNp-239	———	———	———
	Co-57	9.52E-01	(12 ± 11)E 00	38E 00
	Ce-144	9.54E-01	(-1 ± 92)E 00	32E 01
	Ce-141	6.66E-01	(15 ± 29)E 00	98E 00
	xMo-99	———	———	———
	Se-75	8.95E-01	(21 ± 17)E 00	58E 00
	Cr-51	6.20E-01	(21 ± 17)E 01	56E 01
	I-131	1.93E-01	(73 ± 67)E 00	22E 01
	Be-7	7.81E-01	(8 ± 15)E 01	52E 01
	Ru-103	7.14E-01	(-10 ± 17)E 00	62E 00
	xI-133	———	———	———
	Ba-140	3.56E-01	(8 ± 12)E 01	41E 01
	Cs-134	9.82E-01	(28 ± 19)E 00	64E 00
	Ru-106	9.64E-01	(-4 ± 13)E 01	47E 01
+*	Cs-137	9.98E-01	(478 ± 35)E 00	73E 00
	Ag-110M	9.48E-01	(2 ± 19)E 00	67E 00
	Zr-95	8.13E-01	(49 ± 27)E 00	89E 00
	Co-58	8.29E-01	(-19 ± 14)E 00	56E 00
	Mn-54	9.58E-01	(5 ± 12)E 00	44E 00
+*	AcTh228	1.00E 00	(691 ± 55)E 00	19E 01
	TeI-132	1.73E-02	(-19 ± 10)E 02	40E 02
	Fe-59	7.43E-01	(-17 ± 56)E 00	21E 01
	Zn-65	9.47E-01	(30 ± 68)E 00	23E 01
	Co-60	9.93E-01	(-47 ± 15)E 00	66E 00
+*	K-40	9.99E-01	(1369 ± 57)E 01	43E 01
	Sb-124	8.02E-01	(7 ± 29)E 00	11E 01
	U-235	1.00E+00	(70 ± 91)E 00	31E+01
+	Th-234	1.00E+00	(133 ± 67)E+01	22E+02
	Am-241	1.00E+00	(54 ± 58)E 00	19E+01

Notes:
* Activity greater than 3 standard deviations
+ Peak is found
x Decay correction is less than .01

Approved by

Reporting level ratio: 0.000

J. M. Raimondi 10/19/00
J. M. Raimondi

DUKE ENGINEERING AND SERVICES
ENVIRONMENTAL LABORATORY

Analysis Report

Customer: Brooks AFB
Attention: TSgt. Karen Glaken

Report Date: 10/09/00
Analysis Date: 10/03/00
Receipt Date: 09/19/00
Reference Date: 09/14/00

Soil

Station No: 20 A50W A26N

Sample Amount: 1.359 kg
Elapsed Time: 18.9767 days
Comment:

Lab Sample #: G56036
Sample Code: ZTS 20 3700
Analyses Req: G

	Nuclide	Decay Correction	Activity Conc. ± σ [picoCurie/ kg-dry]	MDC
	xNp-239	----	----	----
	Co-57	9.52E-01	(1 ± 12)E 00	42E 00
	Ce-144	9.54E-01	(-52 ± 94)E 00	33E 01
	Ce-141	6.67E-01	(40 ± 33)E 00	11E 01
	xMo-99	----	----	----
	Se-75	8.95E-01	(9 ± 20)E 00	69E 00
	Cr-51	6.22E-01	(4 ± 18)E 01	61E 01
	I-131	1.94E-01	(-12 ± 68)E 00	24E 01
	Be-7	7.81E-01	(13 ± 14)E 01	47E 01
	Ru-103	7.15E-01	(0 ± 18)E 00	63E 00
	xI-133	----	----	----
	Ba-140	3.57E-01	(3 ± 14)E 01	49E 01
	Cs-134	9.82E-01	(-10 ± 13)E 00	50E 00
	Ru-106	9.64E-01	(2 ± 15)E 01	52E 01
+*	Cs-137	9.98E-01	(378 ± 33)E 00	72E 00
	Ag-110M	9.48E-01	(0 ± 18)E 00	68E 00
	Zr-95	8.14E-01	(-28 ± 29)E 00	11E 01
	Co-58	8.30E-01	(-12 ± 12)E 00	50E 00
	Mn-54	9.58E-01	(-15 ± 14)E 00	53E 00
+*	AcTh228	1.00E 00	(779 ± 68)E 00	22E 01
	TeI-132	1.76E-02	(-21 ± 18)E 02	65E 02
	Fe-59	7.44E-01	(3 ± 59)E 00	22E 01
	Zn-65	9.47E-01	(126 ± 69)E 00	23E 01
	Co-60	9.93E-01	(-10 ± 14)E 00	56E 00
+*	K-40	9.99E-01	(1342 ± 63)E 01	63E 01
	Sb-124	8.03E-01	(-33 ± 24)E 00	12E 01
	U-235	1.00E 00	(-10 ± 10)E+01	36E+01
+*	Th-234	1.00E 00	(385 ± 72)E+01	25E+02
	Am-241	1.00E 00	(133 ± 75)E 00	25E+01

Notes:
* Activity greater than 3 standard deviations
+ Peak is found
x Decay correction is less than .01

Reporting level ratio: 0.000

Approved by
J. M. Raimondi 10/18/00

DUKE ENGINEERING AND SERVICES
ENVIRONMENTAL LABORATORY

Analysis Report

Customer: Brooks AFB
Attention: TSgt. Karen Glaken

Report Date: 10/09/00
Analysis Date: 10/03/00
Receipt Date: 09/19/00
Reference Date: 09/14/00

Soil

Station No: 21 A14W A33N

Sample Amount: 1.366 kg
Elapsed Time: 18.9778 days
Comment:

Lab Sample #: G56037
Sample Code: ZTS 21 3700
Analyses Req: G

	Nuclide	Decay Correction	Activity Conc. ± σ [picoCurie/kg-dry]	MDC
	xNp-239	----	----	----
	Co-57	9.52E-01	(-6 ± 12)E 00	42E 00
	Ce-144	9.54E-01	(-20 ± 96)E 00	33E 01
	Ce-141	6.67E-01	(70 ± 33)E 00	11E 01
	xMo-99	----	----	----
	Se-75	8.95E-01	(3 ± 20)E 00	68E 00
	Cr-51	6.21E-01	(25 ± 19)E 01	62E 01
	I-131	1.94E-01	(-70 ± 72)E 00	26E 01
	Be-7	7.81E-01	(23 ± 17)E 01	58E 01
	Ru-103	7.15E-01	(16 ± 18)E 00	63E 00
	xI-133	----	----	----
	Ba-140	3.57E-01	(-11 ± 14)E 01	53E 01
	Cs-134	9.82E-01	(-10 ± 14)E 00	51E 00
	Ru-106	9.64E-01	(-15 ± 12)E 01	49E 01
+*	Cs-137	9.98E-01	(458 ± 36)E 00	73E 00
	Ag-110M	9.48E-01	(13 ± 22)E 00	77E 00
	Zr-95	8.14E-01	(-40 ± 30)E 00	12E 01
	Co-58	8.30E-01	(0 ± 16)E 00	58E 00
	Mn-54	9.58E-01	(2 ± 16)E 00	60E 00
+*	AcTh228	1.00E 00	(857 ± 72)E 00	23E 01
	TeI-132	1.76E-02	(-11 ± 11)E 02	43E 02
	Fe-59	7.44E-01	(-81 ± 60)E 00	24E 01
	Zn-65	9.47E-01	(117 ± 87)E 00	29E 01
	Co-60	9.93E-01	(21 ± 18)E 00	61E 00
+*	K-40	9.99E-01	(1371 ± 69)E 01	79E 01
	Sb-124	8.03E-01	(0 ± 19)E 00	90E 00
	U-235	1.00E 00	(78 ± 99)E 00	33E+01
+	Th-234	1.00E 00	(109 ± 53)E+01	17E+02
	Am-241	1.00E 00	(43 ± 66)E 00	22E+01

Approved by

Notes:
* Activity greater than 3 standard deviations
+ Peak is found
x Decay correction is less than .01

Reporting level ratio: 0.000

J. M. Raimondi 10/18/00
J. M. Raimondi

DUKE ENGINEERING AND SERVICES
ENVIRONMENTAL LABORATORY

Analysis Report

Customer: Brooks AFB
Attention: TSgt. Karen Glaken

Report Date: 10/09/00
Analysis Date: 10/03/00
Receipt Date: 09/19/00
Reference Date: 09/14/00

Soil

Station No: 22 A38W A33N

Sample Amount: 1.458 kg
Elapsed Time: 18.9791 days
Comment:

Lab Sample #: G56038
Sample Code: ZTS 22 3700
Analyses Req: G

	Nuclide	Decay Correction	Activity Conc. ± σ [picoCurie/ kg-dry]	MDC
	xNp-239	----	----	----
	Co-57	9.52E-01	(-18 ± 11)E 00	40E 00
	Ce-144	9.54E-01	(-100 ± 92)E 00	32E 01
	Ce-141	6.67E-01	(36 ± 31)E 00	10E 01
	xMo-99	----	----	----
	Se-75	8.95E-01	(-45 ± 20)E 00	75E 00
	Cr-51	6.21E-01	(-25 ± 18)E 01	66E 01
	I-131	1.94E-01	(48 ± 65)E 00	22E 01
	Be-7	7.81E-01	(12 ± 14)E 01	49E 01
	Ru-103	7.15E-01	(12 ± 17)E 00	59E 00
	xI-133	----	----	----
	Ba-140	3.57E-01	(13 ± 14)E 01	48E 01
	Cs-134	9.82E-01	(-5 ± 12)E 00	48E 00
	Ru-106	9.64E-01	(-7 ± 14)E 01	52E 01
+*	Cs-137	9.98E-01	(417 ± 33)E 00	64E 00
	Ag-110M	9.48E-01	(-38 ± 23)E 00	90E 00
	Zr-95	8.14E-01	(31 ± 27)E 00	92E 00
	Co-58	8.30E-01	(-15 ± 14)E 00	56E 00
	Mn-54	9.58E-01	(2 ± 17)E 00	62E 00
+*	AcTh228	1.00E 00	(786 ± 65)E 00	20E 01
	TeI-132	1.76E-02	(20 ± 19)E 02	64E 02
	Fe-59	7.44E-01	(19 ± 54)E 00	20E 01
	Zn-65	9.47E-01	(-114 ± 76)E 00	28E 01
	Co-60	9.93E-01	(-29 ± 16)E 00	69E 00
+*	K-40	9.99E-01	(1486 ± 68)E 01	66E 01
	Sb-124	8.03E-01	(27 ± 20)E 00	66E 00
	U-235	1.00E 00	(92 ± 94)E 00	36E+01
+	Th-234	1.00E 00	(141 ± 73)E+01	24E+02
	Am-241	1.00E 00	(162 ± 62)E 00	20E+01

Notes:
* Activity greater than 3 standard deviations
+ Peak is found
x Decay correction is less than .01

Approved by

Reporting level ratio: 0.000

D. M. Raimondi 10/18/00

DUKE ENGINEERING AND SERVICES
ENVIRONMENTAL LABORATORY

Analysis Report

Customer: Brooks AFB
Attention: TSgt. Karen Glaken

Report Date: 10/09/00
Analysis Date: 10/03/00
Receipt Date: 09/19/00
Reference Date: 09/14/00

Soil

Station No: 23 A02W A40N

Sample Amount: 1.382 kg
Elapsed Time: 18.9803 days
Comment:

Lab Sample #: G56039
Sample Code: ZTS 23 3700
Analyses Req: G

	Nuclide	Decay Correction	Activity Conc. ± σ [picoCurie/ kg-dry]	MDC
	xNp-239			
	Co-57	9.52E-01	(11 ± 11)E 00	38E 00
	Ce-144	9.54E-01	(-78 ± 87)E 00	31E 01
	Ce-141	6.67E-01	(13 ± 28)E 00	95E 00
	xMo-99			
	Se-75	8.95E-01	(-23 ± 18)E 00	64E 00
	Cr-51	6.21E-01	(-23 ± 16)E 01	58E 01
	I-131	1.94E-01	(-5 ± 64)E 00	22E 01
	Be-7	7.81E-01	(11 ± 12)E 01	41E 01
	Ru-103	7.15E-01	(14 ± 15)E 00	50E 00
	xI-133			
	Ba-140	3.57E-01	(-25 ± 13)E 01	51E 01
	Cs-134	9.82E-01	(-6 ± 11)E 00	40E 00
	Ru-106	9.64E-01	(-17 ± 11)E 01	44E 01
+*	Cs-137	9.98E-01	(450 ± 29)E 00	50E 00
	Ag-110M	9.48E-01	(9 ± 18)E 00	62E 00
	Zr-95	8.14E-01	(21 ± 24)E 00	81E 00
	Co-58	8.30E-01	(-16 ± 13)E 00	52E 00
	Mn-54	9.58E-01	(-5 ± 14)E 00	50E 00
+*	AcTh228	1.00E 00	(728 ± 53)E 00	18E 01
	TeI-132	1.76E-02	(-235 ± 91)E 01	37E 02
	Fe-59	7.44E-01	(-13 ± 47)E 00	17E 01
	Zn-65	9.47E-01	(-100 ± 63)E 00	23E 01
	Co-60	9.93E-01	(11 ± 12)E 00	42E 00
+*	K-40	1.00E 00	(1419 ± 55)E 01	44E 01
	Sb-124	8.03E-01	(12 ± 15)E 00	58E 00
	U-235	1.00E+00	(-97 ± 86)E 00	30E+01
+	Th-234	1.00E+00	(124 ± 58)E+01	25E+02
	Am-241	1.00E+00	(63 ± 85)E+00	29E+01

Approved by

Notes:
* Activity greater than 3 standard deviations
+ Peak is found
x Decay correction is less than .01

Reporting level ratio: 0.000

J. M. Raimondi 10/18/00

DUKE ENGINEERING AND SERVICES
ENVIRONMENTAL LABORATORY

Analysis Report

Customer: Brooks AFB
Attention: TSgt. Karen Glaken

Report Date: 10/09/00
Analysis Date: 10/03/00
Receipt Date: 09/19/00
Reference Date: 09/14/00

Soil

Station No: 24 A26W A40N

Sample Amount: 1.459 kg
Elapsed Time: 18.9812 days
Comment:

Lab Sample #: G56040
Sample Code: ZTS 24 3700
Analyses Req: G

	Nuclide	Decay Correction	Activity Conc. ± σ [picoCurie/kg-dry]	MDC
	xNp-239	----	----	----
	Co-57	9.52E-01	(-12 ± 10)E 00	36E 00
	Ce-144	9.54E-01	(-16 ± 82)E 00	28E 01
	Ce-141	6.67E-01	(36 ± 26)E 00	85E 00
	xMo-99	----	----	----
	Se-75	8.95E-01	(-7 ± 17)E 00	61E 00
	Cr-51	6.21E-01	(-15 ± 15)E 01	54E 01
	I-131	1.94E-01	(-4 ± 56)E 00	20E 01
	Be-7	7.81E-01	(9 ± 12)E 01	42E 01
	Ru-103	7.15E-01	(-11 ± 14)E 00	52E 00
	xI-133	----	----	----
	Ba-140	3.57E-01	(8 ± 12)E 01	40E 01
	Cs-134	9.82E-01	(0 ± 12)E 00	41E 00
	Ru-106	9.64E-01	(-5 ± 11)E 01	39E 01
+*	Cs-137	9.98E-01	(628 ± 32)E 00	51E 00
	Ag-110M	9.48E-01	(-6 ± 15)E 00	57E 00
	Zr-95	8.14E-01	(18 ± 20)E 00	67E 00
	Co-58	8.30E-01	(30 ± 19)E 00	63E 00
	Mn-54	9.58E-01	(15 ± 12)E 00	41E 00
+*	AcTh228	1.00E 00	(826 ± 55)E 00	16E 01
	TeI-132	1.76E-02	(21 ± 13)E 02	43E 02
	Fe-59	7.44E-01	(-5 ± 38)E 00	14E 01
	Zn-65	9.47E-01	(-113 ± 64)E 00	23E 01
	Co-60	9.93E-01	(14 ± 11)E 00	38E 00
+*	K-40	9.98E-01	(1448 ± 52)E 01	37E 01
	Sb-124	8.03E-01	(14 ± 18)E 00	68E 00
	U-235	1.00E 00	(2 ± 78)E 00	27E+01
+	Th-234	1.00E 00	(108 ± 51)E+01	17E+02
	Am-241	1.00E 00	(-138 ± 79)E 00	28E+01

Notes:
* Activity greater than 3 standard deviations
+ Peak is found
x Decay correction is less than .01

Approved by

Reporting level ratio: 0.000

J. M. Raimondi 10/18/00

DUKE ENGINEERING AND SERVICES
ENVIRONMENTAL LABORATORY

Analysis Report

Customer: Brooks AFB
Attention: TSgt. Karen Glaken

Report Date: 10/09/00
Analysis Date: 10/03/00
Receipt Date: 09/19/00
Reference Date: 09/14/00

Soil

Station No: 25 A14W A47N

Sample Amount: 1.601 kg
Elapsed Time: 18.9821 days
Comment:

Lab Sample #: G56041
Sample Code: ZTS 25 3700
Analyses Req: G

	Nuclide	Decay Correction	Activity Conc. ± σ [picoCurie/kg-dry]	MDC
	xNp-239			
	Co-57	9.52E-01	(-10 ± 10)E 00	37E 00
	Ce-144	9.54E-01	(-101 ± 87)E 00	30E 01
	Ce-141	6.67E-01	(24 ± 28)E 00	92E 00
	xMo-99			
	Se-75	8.95E-01	(10 ± 14)E 00	49E 00
	Cr-51	6.21E-01	(-14 ± 15)E 01	54E 01
	I-131	1.94E-01	(105 ± 50)E 00	16E 01
	Be-7	7.81E-01	(-5 ± 11)E 01	40E 01
	Ru-103	7.15E-01	(13 ± 12)E 00	42E 00
	xI-133			
	Ba-140	3.57E-01	(-43 ± 92)E 00	34E 01
	Cs-134	9.82E-01	(-8 ± 11)E 00	40E 00
	Ru-106	9.64E-01	(6 ± 10)E 01	35E 01
+*	Cs-137	9.98E-01	(93 ± 20)E 00	57E 00
	Ag-110M	9.48E-01	(-8 ± 14)E 00	52E 00
	Zr-95	8.14E-01	(42 ± 51)E 00	17E 01
	Co-58	8.30E-01	(-25 ± 11)E 00	46E 00
	Mn-54	9.58E-01	(8 ± 12)E 00	40E 00
+*	AcTh228	1.00E 00	(770 ± 50)E 00	17E 01
	TeI-132	1.76E-02	(-69 ± 88)E 01	33E 02
	Fe-59	7.44E-01	(53 ± 43)E 00	15E 01
	Zn-65	9.47E-01	(30 ± 59)E 00	20E 01
	Co-60	9.93E-01	(-8 ± 11)E 00	44E 00
+*	K-40	9.98E-01	(1335 ± 51)E 01	38E 01
	Sb-124	8.03E-01	(0 ± 22)E 00	89E 00
	U-235	1.00E 00	(66 ± 87)E 00	29E+01
+*	Th-234	1.00E 00	(427 ± 31)E+01	92E+01
	Am-241	1.00E 00	(-6 ± 66)E 00	23E+01

Notes:
* Activity greater than 3 standard deviations
+ Peak is found
x Decay correction is less than .01

Approved by

Reporting level ratio: 0.000

J. M. Raimondi 10/18/00

DUKE ENGINEERING AND SERVICES
ENVIRONMENTAL LABORATORY

Analysis Report

Customer: Brooks AFB
Attention: TSgt. Karen Glaken

Report Date: 10/09/00
Analysis Date: 10/03/00
Receipt Date: 09/19/00
Reference Date: 09/14/00

Soil

Station No: 26 A02W A54N

ample Amount:1 1.310 kg
Elapsed Time: 19.0409 days
Comment:

Lab Sample #: G56042
Sample Code: ZTS 26 3700
Analyses Req: G

Nuclide	Decay Correction	Activity Conc. ± σ [picoCurie/ kg-dry]	MDC
xNp-239	———	———	———
Co-57	9.52E-01	(-3 ± 10)E 00	36E 00
Ce-144	9.54E-01	(-174 ± 82)E 00	30E 01
Ce-141	6.66E-01	(48 ± 29)E 00	94E 00
xMo-99	———	———	———
Se-75	8.95E-01	(5 ± 18)E 00	62E 00
Cr-51	6.20E-01	(17 ± 16)E 01	55E 01
I-131	1.93E-01	(-119 ± 61)E 00	23E 01
Be-7	7.81E-01	(7 ± 13)E 01	47E 01
u-103	7.14E-01	(7 ± 16)E 00	56E 00
-133	———	———	———
Ba-140	3.56E-01	(6 ± 13)E 01	47E 01
Cs-134	9.82E-01	(10 ± 34)E 00	12E 01
Ru-106	9.64E-01	(-5 ± 11)E 01	42E 01
Cs-137	9.98E-01	(323 ± 30)E 00	69E 00
Ag-110M	9.48E-01	(-4 ± 15)E 00	58E 00
Zr-95	8.13E-01	(12 ± 24)E 00	84E 00
Co-58	8.29E-01	(-10 ± 13)E 00	51E 00
Mn-54	9.58E-01	(-16 ± 14)E 00	53E 00
AcTh228	1.00E 00	(530 ± 57)E 00	23E 01
TeI-132	1.74E-02	(5 ± 17)E 02	57E 02
Fe-59	7.43E-01	(50 ± 53)E 00	18E 01
Zn-65	9.47E-01	(-61 ± 74)E 00	26E 01
Co-60	9.93E-01	(15 ± 13)E 00	43E 00
K-40	9.97E-01	(1420 ± 59)E 01	54E 01
Sb-124	8.03E-01	(0 ± 24)E 00	98E 00
U-235	1.00E 00	(122 ± 88)E 00	29E+01
Th-234	1.00E 00	(228 ± 49)E+01	16E+02
Am-241	1.00E 00	(27 ± 11)E+01	34E+01

tes:
: Activity greater than 3 standard deviations
· Peak is found
: Decay correction is less than .01

porting level ratio: 0.000

Approved by

J. M. Raimondi 10/10/00

DUKE ENGINEERING AND SERVICES
ENVIRONMENTAL LABORATORY

Analysis Report

Customer: Brooks AFB
Attention: TSgt. Karen Glacken

Report Date: 10/19/00
Analysis Date: 10/03/00
Receipt Date: 09/19/00
Reference Date: 09/14/00

Soil

Station No: 27 A18W A54N

Sample Amount: 0.568 kg
Elapsed Time: 19.0431 days
Comment:

Lab Sample #: G56043
Sample Code: ZTS 27 3700
Analyses Req: G

	Nuclide	Decay Correction	Activity Conc. ± σ [picoCurie/kg-dry]	MDC
	xNp-239	———	———	———
	Co-57	9.52E-01	(-4 ± 13)E 00	44E 00
	Ce-144	9.54E-01	(-5 ± 97)E 00	33E 01
	Ce-141	6.66E-01	(26 ± 32)E 00	11E 01
	xMo-99	———	———	———
	Se-75	8.95E-01	(-22 ± 19)E 00	67E 00
	Cr-51	6.20E-01	(2 ± 17)E 01	58E 01
	I-131	1.93E-01	(-16 ± 68)E 00	24E 01
	Be-7	7.81E-01	(9 ± 13)E 01	45E 01
	Ru-103	7.14E-01	(24 ± 17)E 00	56E 00
	xI-133	———	———	———
	Ba-140	3.56E-01	(-10 ± 12)E 01	46E 01
	Cs-134	9.82E-01	(27 ± 22)E 00	73E 00
	Ru-106	9.64E-01	(6 ± 12)E 01	41E 01
	Cs-137	9.98E-01	(38 ± 15)E 00	48E 00
	Ag-110M	9.48E-01	(5 ± 16)E 00	58E 00
	Zr-95	8.13E-01	(-4 ± 27)E 00	97E 00
	Co-58	8.29E-01	(-36 ± 16)E 00	63E 00
	Mn-54	9.58E-01	(8 ± 15)E 00	52E 00
+*	AcTh228	1.00E 00	(736 ± 64)E 00	20E 01
	TeI-132	1.73E-02	(-9 ± 17)E 02	61E 02
	Fe-59	7.43E-01	(-28 ± 41)E 00	16E 01
	Zn-65	9.47E-01	(90 ± 71)E 00	23E 01
	Co-60	9.93E-01	(-5 ± 14)E 00	52E 00
+*	K-40	9.99E-01	(1349 ± 56)E 01	60E 01
	Sb-124	8.02E-01	(-66 ± 27)E 00	13E 01
	U-235	1.00E+00	(251 ± 99)E 00	32E+01
+*	Th-234	1.00E+00	(586 ± 80)E+01	33E+02
	Am-241	1.00E+00	(22 ± 22)E+01	74E+01

Notes:
* Activity greater than 3 standard deviations
+ Peak is found
x Decay correction is less than .01

Reporting level ratio: 0.000

Approved by

J. M. Raimondi 10/19/00

Appendix E

Waste Manifest

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TEXAS NATURAL RESOURCE
CONSERVATION COMMISSION
P.O. Box 13087
Austin, Texas 78711-3087

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form approved. OMB No. 2050-0039.

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. ID954002447 2CES011 Manifest Document No.

2. Page 1 of

Information in the shaded areas is not required by Federal law.

3. Generator's Name and Mailing Address
US Army, Operations Support Command
Amsio-ACE-D Rock Island, IL 61299
FOR
Grissom Air Reserve
Grissom ARB, IN

4. Generator's Phone (309) 782-0338

5. Transporter 1 Company Name
Wills Trucking

6. US EPA ID Number
OHD 068913409

7. Transporter 2 Company Name

8. US EPA ID Number

9. Designated Facility Name and Site Address
Waste Control Specialists
1210 W. Broadway
Andrews, TX 61299

10. US EPA ID Number
TXD 988088464

11A. HM	11. US DOT Description (including Proper Shipping Name, Hazard Class, ID Number and Packing Group)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol
	a. WASTE, NON RCRA, NON REGULATED Soil and Grass (DOT Radioactive Exempt)	001	CM	23905	P
	b.				
	c.				
	d.				

GENERATOR

Additional Descriptions for Materials Listed Above

K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information
Container ID- BKRU 25569 Waste Profile- WP13518
Volume of Waste- 10.0 yd^3 Depleted Uranium - 0.176 mCi

16. **GENERATOR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packaged, marked, and labelled/placarded, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations, including applicable state regulations.
If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

Printed/Typed Name: Richard Thatcher Agent of U.S Army | Signature: Richard D Thatcher | Month Day Year: 10 18 00

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials

Printed/Typed Name: Jim Wolff | Signature | Date: Month Day Year: 10 18 00

18. Transporter 2 Acknowledgement of Receipt of Materials

Printed/Typed Name | Signature | Date: Month Day Year

19. Discrepancy Indication Space

FACILITY

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.

Printed/Typed Name | Date: Month Day Year

TEXAS NATURAL RESOURCE
CONSERVATION COMMISSION
P.O. Box 13087
Austin, Texas 78711-3087

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UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. TXD 954002447 Manifest Document No. 2ESØ12

2. Page 1 of 1

Information in the shaded areas is not required by Federal law.

3. Generator's Name and Mailing Address
USARMY, OPERATIONS SUPPORT COMMAND
AMSIO-ACE-D ROCK ISLAND, IL 61299
FOR GRISSOM AIR RESERVE GRISSOM AFB, IN

4. Generator's Phone (309) 782-0338

5. Transporter 1 Company Name: WILLS TRUCKING

6. US EPA ID Number: OKD 068913409

7. Transporter 2 Company Name

8. US EPA ID Number

9. Designated Facility Name and Site Address
WASTE CONTROL SPECIALISTS
1710 W. BROADWAY
ANDREWS, TX 61299

10. US EPA ID Number: TXD 988088464

State Manifest Document Number: 0208968

State Generator ID: 99918

State Transporter's ID:

Transporter's Phone:

State Transporter's ID:

State Facility's ID: 50356

Facility's Phone: 806-997-2283

11A. HM	11. US DOT Description (including Proper Shipping Name, Hazard Class, ID Number and Packing Group)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol
	a. WASTE, NON RCRA, NON REGULATED SOIL AND GRASS (DOT RADIOACTIVE EXEMPT)	ØØ1	CM	18790	P
	b.				
	c.				
	d.				

J. Additional Descriptions for Materials Listed Above

K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information
CONTAINER ID - BKRU 26504 WASTE PROFILE - WP13518
VOLUME OF WASTE - 7.8 yd3 DEPLETED URANIUM - 0.138 mCi

16. **GENERATOR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packaged, marked, and labelled/placarded, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations, including applicable state regulations.
If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

Printed/Typed Name: RICHARD THATCHER AGENT OF US ARMY | Signature: Richard Thatcher | Month Day Year: 10 18 00

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name: GEORGE JACKSON | Signature: George Jackson | Date: NOV 8 00

18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name | Signature | Date

19. Discrepancy Indication Space

FACILITY

20. Facility Owner or Operator: Certification of receipt of h... est except as noted in Item 19.
Printed/Typed Name | Date

TEXAS NATURAL RESOURCE
CONSERVATION COMMISSION
P.O. Box 13087
Austin, Texas 78711-3087

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UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. IN9540024472 Manifest Document No. 02063152

2. Page 1 of 1

Information in the shaded areas is not required by Federal law.

3. Generator's Name and Mailing Address
CABRERA SERVICES FOR
U.S. ARMY, OPERATIONS SUPPORT COMMAND
AMSIO-ACE-D ROCK ISLAND, IL 61299
AF K00-004
GRISSOM AIR RESERVE
GRISSOM, ARB, IN

4. Generator's Phone (309) 782-0338

A. State Manifest Document Number: 02063152
B. State Generator's ID: 99918

5. Transporter 1 Company Name: WILLS TRANSPORT
6. US EPA ID Number: OHD068913409
C. State Transporter's ID:
D. Transporter's Phone: 800-752-4555

7. Transporter 2 Company Name
8. US EPA ID Number
E. State Transporter's ID:
F. Transporter's Phone:

9. Designated Facility Name and Site Address
WASTE CONTROL SPECIALISTS LLC
;710 W. BROADWAY
ANDREWS, TX 79714
10. US EPA ID Number: TXD988088464
G. State Facility's ID: 50358
H. Facility's Phone: 888-289-2983

11A. HM	11. US DOT Description (including Proper Shipping Name, Hazard Class, ID Number and Packing Group)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	Waste No.
	a. WASTE, NON RCRA, NON REGULATED SOIL AND GRASS (DOT RADIOACTIVE EXEMPT)	001	CM	26020	P	OUTS 3191
	b.					
	c.					
	d.					

J. Additional Descriptions for Materials Listed Above

K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information: WASTE PROFILE - WP13518
CONTAINER ID - BKRL 25253
VOLUME OF WASTE - 8.3 yd^3 DEPLETED URANIUM - 0.146 mCi

16. **GENERATOR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packaged, marked, and labelled/placarded, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations, including applicable state regulations.
If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

Printed/Typed Name: RICHARD THATCHER (DEPT OF U.S. Army) Signature: Richard Thatcher Month 10 Day 19 Year 10

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name: JIM WOLFF Signature: Jim Wolff Date: Month 10 Day 18 Year 10

18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name: Signature: Date: Month Day Year

FACILITY

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.
Printed/Typed Name: Date: Month Day Year

TNRCC-0311 (Rev. 07/01/97) White-Transporter Green-Generator's first copy

TEXAS NATURAL RESOURCE
CONSERVATION COMMISSION
P.O. Box 13087
Austin, Texas 78711-3087

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UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. IN9540024472 Manifest Document No. CS882
2. Page 1 of
Information in the shaded areas is not required by Federal law.

3. Generator's Name and Mailing Address
US. ARMY OPERATIONS SUPPORT COMMAND
AMSIO-ACE-D ROCK ISLAND, IL 61299
FOR GRISSOM AIR RESERVE
GRISSOM, AFB, IN

4. Generator's Phone (309) 782-0338

5. Transporter 1 Company Name
WILLS TRUCKING

6. US EPA ID Number
TXD068913409

7. Transporter 2 Company Name

8. US EPA ID Number

9. Designated Facility Name and Site Address
WASTE CONTROL SPECIALISTS, LLC
1710 W. BROADWAY
ANDREWS, TX 79714

10. US EPA ID Number
TXD988088464

11A. HM	11. US DOT Description (including Proper Shipping Name, Hazard Class, ID Number and Packing Group)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol
	a. WASTE, NON RCRA, NON REGULATED SOIL AND GRASS (DOT RADIOACTIVE EXEMPT)	001	CM	19.90	P
	b.				
	c.				
	d.				

GENERATOR

15. Special Handling Instructions and Additional Information
WASTE PROFILE - WP13518
CONTAINER ID - BKRU 12593
VOLUME OF WASTE - 8 yd3
DEPLETED URANIUM - 0.14 mCi

16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packaged, marked, and labelled/placarded, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations, including applicable state regulations.
If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

Printed/Typed Name: RICHARD THATCHER AGENT OF US ARMY | Signature: Richard Thatcher | Month 10 Day 18 Year 00

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name: BILL CRAWFORD | Signature: Bill Crawford | Date: Month 10 Day 18 Year 00

18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name | Signature | Date: Month Day Year

FACILITY

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of ifest except as noted in Item 19.
Printed/Typed Name | Date: Month Day Year

TEXAS NATURAL RESOURCE
CONSERVATION COMMISSION
P.O. Box 13087
Austin, Texas 78711-3087

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UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. TND954002447 Manifest Document No. 25883
2. Page 1 of 1
Information in the shaded area is not required by Federal law

3. Generator's Name and Mailing Address
US. ARMY, OPERATIONS SUPPORT COMMAND
AMSIO-ACE-D ROCK ISLAND, IL 61299
FOR GRISSOM AIR RESERVE GRISSOM AFB, IN
4. Generator's Phone (309) 782-0338

A. State Manifest Document Number 02063150
B. State Generator's ID 99918

5. Transporter 1 Company Name WILLS TRUCKING
6. US EPA ID Number IND 068913409
C. State Transporter's ID
D. Transporter's Phone

7. Transporter 2 Company Name
8. US EPA ID Number
E. State Transporter's ID
F. Transporter's Phone

9. Designated Facility Name and Site Address
WASTE CONTROL SPECIALISTS, LLC
1710 W. BROADWAY
ANDREWS, TX 79714
10. US EPA ID Number TXD988088464
G. State Facility's ID 50358
H. Facility's Phone 888-789-2783

11A. HM	11. US DOT Description (including Proper Shipping Name, Hazard Class, ID Number and Packing Group)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
	a. WASTE, NON RCRA, NON REGULATED SOIL AND GRASS (DOT RADIOACTIVE EXEMPT)	001	CM	29330	P	000539191
	b.					
	c.					
	d.					

J. Additional Descriptions for Materials Listed Above
K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information WASTE PROFILE - WP13518
CONTAINER ID - BKRU 12613
VOLUME OF WASTE - 12.2 yd^3 DEPLETED URANIUM - 0.216 mC

16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packaged, marked, and labelled/placarded, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations, including applicable state regulations.
If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

GENERATOR
Printed/Typed Name RICHARD THATCHER AGENT OF US ARMY
Signature Richard Thatcher
Month Day Year 10 / 8 / 02

TRANSPORTER
17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name ROBERT V STUBBLE JR
Signature Robert V Stubble Jr
Date Month Day Year 10 / 8 / 02
18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name
Signature
Date Month Day Year

FACILITY
19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.
Printed/Typed Name
Date Month Day Year

TNRCC-0311 (Rev. 07/01/97) White-Transporter Green-Generator's first copy

TEXAS NATURAL RESOURCE
CONSERVATION COMMISSION
P.O. Box 13087
Austin, Texas 78711-3087

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Form approved. OMB No. 2050-0039.

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. IND 954 002 447 | Manifest Document No. 25884 | 2. Page 1 of 1 | Information in the shaded areas is not required by Federal law.

3. Generator's Name and Mailing Address
U.S. ARMY, OPERATIONS SUPPORT COMMAND
AMSO-ACE-D ROCK ISLAND, IL 61299
For GRISSOM AIR RESERVE BASE GRISSOM AFB, IN

4. Generator's Phone (309) 782-0338

A. State Manifest Document Number 02053526
B. State Generator's ID 99918

5. Transporter 1 Company Name: WILLS TRUCKING | 6. US EPA ID Number: OHD 069 913 409
C. State Transporter's ID
D. Transporter's Phone

7. Transporter 2 Company Name | 8. US EPA ID Number
E. State Transporter's ID
F. Transporter's Phone

9. Designated Facility Name and Site Address
WASTE CONTROL SPECIALISTS, LLC
1910 W. BROADWAY
ANDREWS, TX 79714

10. US EPA ID Number: TXD 988 088 464
G. State Facility's ID 50358
H. Facility's Phone 888-789-2783

11A. HM	11. US DOT Description (including Proper Shipping Name, Hazard Class, ID Number and Packing Group)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
	a. WASTE, NON RCRA, NON REGULATED SOIL AND GRASS (DOT RADIOACTIVE EXEMPT)	001	CM	25870	P	0445 319
	b.					
	c.					
	d.					

J. Additional Descriptions for Materials Listed Above

K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information WASTE PROFILE - WP13518
CONTAINER ID - ~~125201~~ BKRL 12820
VOLUME OF WASTE - 10.8 yd³ DEPLETED URANIUM - 0.19 mCi

16. **GENERATOR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packaged, marked, and labelled/placarded, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations, including applicable state regulations.
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Printed/Typed Name: RICHARD THATCHER AGENT OF US ARMY | Signature: Richard C. Thatcher | Month 10 Day 13 Year 00

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name: BILL CRAWFORD | Signature: Bill Crawford | Date: Month 10 Day 18 Year 00

18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name | Signature | Date: Month Day Year

FACILITY

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt c ... inifest except as noted in Item 19.
Printed/Typed Name | Date: Month Day Year

TNRCC-0311 (Rev. 07/01/97) ... ow-Transporter Green-Generator's first copy

TEXAS NATURAL RESOURCE
CONSERVATION COMMISSION
P.O. Box 13087
Austin, Texas 78711-3087

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

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UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. TXD954002472 Manifest Document No. C5085

2. Page 1 of 1

Information in the shaded areas is not required by Federal law.

3. Generator's Name and Mailing Address
U.S. ARMY, OPERATIONS SUPPORT COMMAND
AMSIO-ACE-ID ROCK ISLAND, IL 61299
For Gassen Air Research Site
Gassen, ARS, IN

4. Generator's Phone (309) 782-0338

A. State Manifest Document Number: 02058527

B. State Generator's ID: 99918

5. Transporter 1 Company Name: WILLS TRUCKING

6. US EPA ID Number: TXD 068913409

C. State Transporter's ID:

D. Transporter's Phone:

7. Transporter 2 Company Name

8. US EPA ID Number

E. State Transporter's ID:

F. Transporter's Phone:

9. Designated Facility Name and Site Address
WASTE CONTROL SPECIALISTS, LLC
1910 W. BROADWAY
ANDREWS, TX 79714

10. US EPA ID Number: TXD 988088464

G. State Facility's ID: 50358

H. Facility's Phone: 888-789-2783

11A. HM	11. US DOT Description (including Proper Shipping Name, Hazard Class, ID Number and Packing Group)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt./Vol.	I. Waste No.
	a. WASTE, NON RCRA, NON REGULATED SOIL AND GRASS (DOT RADIOACTIVE EXEMPT)	001	CM	20590	P	OUTS3191
	b.					
	c.					
	d.					

J. Additional Descriptions for Materials Listed Above

K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information
WASTE PROFILE - WP13518
CONTAINER ID-BKRU25170
VOLUME OF WASTE - 8.6 yd3
DEPLETED URANIUM - 0.15 MT

16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packaged, marked, and labelled/placarded, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations, including applicable state regulations.
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GENERATOR

Printed/Typed Name: RICHARD THATCHER AGENT OF US ARMY
Signature: [signature]
Month 01 Day 18 Year 02

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name: BERAGE JACKSON
Signature: [signature]
Date: Month 01 Day 18 Year 02

18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name
Signature
Date: Month Day Year

FACILITY

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.
Printed/Typed Name
Date: Month Day Year

TNRCC-0311 (Rev. 07/01/97) Yellow-Transporter Green-Generator's first copy

TEXAS NATURAL RESOURCE
CONSERVATION COMMISSION
P.O. Box 13087
Austin, Texas 78711-3087

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UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. IN9540024472 — Manifest Document No. 2CS00
2. Page 1 of 1

Information in the shaded area is not required by Federal law

3. Generator's Name and Mailing Address
US ARMY OPERATIONS SUPPORT Com. AMSIO-ACE-D ROCK ISLAND IL 61299
FOR GRISSOM AIR RESERVE GRISSOM ARB, IN

A. State Manifest Document Number 1020535218

4. Generator's Phone (309) 782-0338

B. State Generator's ID 99918

5. Transporter 1 Company Name WILLS TRUCKING
6. US EPA ID Number OHD 068913409

C. State Transporter's ID
D. Transporter's Phone

7. Transporter 2 Company Name
8. US EPA ID Number

E. State Transporter's ID
F. Transporter's Phone

9. Designated Facility Name and Site Address
WASTE CONTROL SPECIALISTS
1910 W. BROADWAY
ANDREWS, TX 79714

10. US EPA ID Number TXD988088464

G. State Facility's ID 50358
H. Facility's Phone 888-789-2783

11A. HM	11. US DOT Description (including Proper Shipping Name, Hazard Class, ID Number and Packing Group)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
	a. WASTE, NON RCRA, NON REGULATED SOIL AND GRASS (DOT RADIOACTIVE EXEMPT)	001	CM	22410	P	OUT5319
	b.					
	c.					
	d.					

J. Additional Descriptions for Materials Listed Above

K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information WASTE PROFILE - WP13518
CONTAINER ID - BKRU 2825~~?~~ 2585
VOLUME OF WASTE - 9.3 yd³
DEPLETED URANIUM - 0.165 mCi

16. **GENERATOR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packaged, marked, and labelled/placarded, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations, including applicable state regulations.
If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

Printed/Typed Name: RICHARD THATCHER AGENT of US ARMY — Signature: [signature] — Month Day Year: 1 1 0 1 1 8 1 0

17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name: GENE REIS — Signature: [signature] — Date Month Day Year: 1 0 1 8 1 0

18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name — Signature — Date Month Day Year

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt ... manifest except as noted in Item 19.

Printed/Typed Name — Date Month Day Year

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TEXAS NATURAL RESOURCE
CONSERVATION COMMISSION
P.O. Box 13087
Austin, Texas 78711-3087

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UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. IN9540024472 Manifest Document No. 05007

2. Page 1 of

Information in the shaded areas is not required by Federal law.

3. Generator's Name and Mailing Address
US ARMY, OPERATIONS SUPPORT COMMAND
AMSIO-ACE-D ROCK ISLAND, IL 61299
FOR
GRISSOM AIR RESERVE
GRISSOM, AFB, IN

4. Generator's Phone (309) 782-0338

5. Transporter 1 Company Name
WILLS TRUCKING

6. US EPA ID Number
OHD068913409

7. Transporter 2 Company Name

8. US EPA ID Number

9. Designated Facility Name and Site Address
WASTE CONTROL SPECIALISTS, LLC
1710 W. BROADWAY
ANDREWS, TX 79714

10. US EPA ID Number
TXD988088464

11A. HM	11. US DOT Description (including Proper Shipping Name, Hazard Class, ID Number and Packing Group)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol
	a. WASTE, NON RCRA, NON REGULATED SOIL AND GRASS (DOT RADIOACTIVE EXEMPT)	001	CM	249.10	P
	b.				
	c.				
	d.				

15. Special Handling Instructions and Additional Information WASTE PROFILE - WY13518
CONTAINER ID - BKRU 25784
VOLUME OF WASTE - 10.4 yd3
DEPLETED URANIUM - 0.183mCi

16. **GENERATOR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packaged, marked, and labelled/placarded, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations, including applicable state regulations.
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GENERATOR

Printed/Typed Name: RICHARD THATCHER AGENT OF US ARMY | Signature | Month 10 Day 18 Year 00

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name: Robert W Stubblefield | Signature | Month 10 Day 18 Year 00

18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name | Signature | Month . Day . Year .

FACILITY

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of haz t except as noted in Item 19.
Printed/Typed Name | Date Month Day Year

TEXAS NATURAL RESOURCE
CONSERVATION COMMISSION
P.O. Box 13087
Austin, Texas 78711-3087

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UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No.	Manifest Document No.	2. Page 1 of	Information in the shaded areas is not required by Federal law.
IN9540024472	25008		

3. Generator's Name and Mailing Address
U.S. Army, Operations Support Command
AMSIO-ACE-D Rock Island, IL 61299
For Grissom AFB Reserve
Grissom AFB, IN

4. Generator's Phone (309) 782-0338

5. Transporter 1 Company Name	6. US EPA ID Number
WILLS TRUCKING	OHD068913409

7. Transporter 2 Company Name	8. US EPA ID Number

9. Designated Facility Name and Site Address	10. US EPA ID Number
WASTE CONTROL SPECIALISTS, LLC 1710 W. BROADWAY ANDREWS, TX 79714	TXD988088464

11A. HM	11. US DOT Description (including Proper Shipping Name, Hazard Class, ID Number and Packing Group)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol
	a. WASTE, NON RCRA, NON REGULATED SOIL AND GRASS (DOT RADIOACTIVE EXEMPT)	001	CM	18390	P
	b.				
	c.				
	d.				

15. Special Handling Instructions and Additional Information
CONTAINER ID - BKRU 25240 WASTE PROFILE - WP13518
VOLUME OF WASTE - 7.7 ~~10.4~~ yd3 DEPLETED URANIUM - 0.135mCi

16. **GENERATOR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packaged, marked, and labelled/placarded, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations, including applicable state regulations.
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Printed/Typed Name	Signature	Month	Day	Year
RICHARD THATCHER AGENT OF US ARMY	Richard D Thatcher	10	18	00

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials

Printed/Typed Name	Signature	Date: Month	Day	Year
GENE REISS	Gene Reiss	10	18	00

18. Transporter 2 Acknowledgement of Receipt of Materials

Printed/Typed Name	Signature	Date: Month	Day	Year

FACILITY

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt o nifest except as noted in Item 19.

Printed/Typed Name — Date: Month Day Year

TEXAS NATURAL RESOURCE
CONSERVATION COMMISSION
P.O. Box 13087
Austin, Texas 78711-3087

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UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. ID954002447 Manifest Document No. 25089
2. Page 1 of 1
Information in the shaded areas is not required by Federal law.

3. Generator's Name and Mailing Address
US ARMY, OPERATIONS SUPPORT COMMAND
AMSIO-ACE-D ROCK ISLAND, IL 61299
FOR GRISSOM AIR RESERVE GRISSOM AFB, IN

4. Generator's Phone (309) 782-0338

5. Transporter 1 Company Name
WILLS TRUCKING

6. US EPA ID Number
OHD068913409

7. Transporter 2 Company Name

8. US EPA ID Number

9. Designated Facility Name and Site Address
WASTE CONTROL SPECIALISTS, LLC
1710 W. BROADWAY
ANDREWS, TX 79714

10. US EPA ID Number
TXD988088464

11A. HM	11. US DOT Description (including Proper Shipping Name, Hazard Class, ID Number and Packing Group)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol
	a. WASTE, NON RCRA, NON REGULATED SOIL AND GRASS (DOT RADIOACTIVE EXEMPT)	001	CM	25530	P
	b.				
	c.				
	d.				

GENERATOR

15. Special Handling Instructions and Additional Information
CONTAINER ID - BKRU 25457 WASTE PROFILE - WP13518
VOLUME OF WASTE - 10.6 yd3 DEPLETED URANIUM - 0.188 mCi

16. **GENERATOR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packaged, marked, and labelled/placarded, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations, including applicable state regulations.
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Printed/Typed Name: RICHARD THATCHER AGENT OF US ARMY | Signature: [signature] | Month 10 Day 19 Year 00

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name: GENE REISS | Signature: [signature] | Date: Month 10 Day 19 Year 00

18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name | Signature | Date: Month . Day . Year .

FACILITY

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of ha st except as noted in Item 19.
Printed/Typed Name | Date: Month Day Year

TEXAS NATURAL RESOURCE
CONSERVATION COMMISSION
P.O. Box 13087
Austin, Texas 78711-3087

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UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. IN9540024472 Manifest Document No. 000 | 2. Page 1 of 1 | Information in the shaded areas is not required by Federal law.

3. Generator's Name and Mailing Address
US ARMY, OPERATIONS SUPPORT COMMAND
AMSIO-ACE-D ROCK ISLAND, IL 61299 For GRISSOM AIR RESERVE
GRISSOM ARB, IN

4. Generator's Phone (309) 782-0338

5. Transporter 1 Company Name: WILLS TRUCKING | 6. US EPA ID Number: IOHD 068913409

7. Transporter 2 Company Name | 8. US EPA ID Number

9. Designated Facility Name and Site Address
WASTE CONTROL SPECIALISTS, LLC
1210 W. BROADWAY
ANDREWS, TX 79714

10. US EPA ID Number: TXD 988088464

11A. HM	11. US DOT Description (including Proper Shipping Name, Hazard Class, ID Number and Packing Group)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol
	a. WASTE, NON RCRA, NON REGULATED SOIL AND GRASS (DOT RADIOACTIVE EXEMPT)	001	CM	23230	P
	b.				
	c.				
	d.				

15. Special Handling Instructions and Additional Information WASTE PROFILE - WP13518
CONTAINER ID - BKRU 25483
VOLUME OF WASTE - 9.7 yd3 DEPLETED URANIUM - 0.17 mCi

16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packaged, marked, and labelled/placarded, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations, including applicable state regulations.
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Printed/Typed Name: RICHARD THATCHER AGENT OF US ARMY | Signature: Richard D Thatcher | Month Day Year: 10 1 1900

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name: BILL CRAWFORD | Signature: Bill Crawford | Date: Month Day Year: 10 1 1900

18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name | Signature | Date: Month Day Year

FACILITY

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of haza except as noted in Item 19.
Printed/Typed Name | Date: Month Day Year